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In this issue:

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Theme: Integration of Motion-Picture and Electronic Systems

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The Colonial Williamsburg Theaters for a Wide-Screen Participation Film

BY ARTHUR L. SMITH and BEN SCHLANGER

The overall planning of the project to provide a participation experience as an introduction to Colonial Williamsburg was previewed in an illustrated lecture in 1955. The evolution and completion of the system are now presented in two brief papers comprising first a sketch of the history and basis for the film presentation system and then a description of the system and facilities.

Planning for the Film Presentation

BY ARTHUR L. SMITH

SINCE ITS opening early in 1957, over 2 million persons have attended Colonial Williamsburg's unique motion-picture theater. They have seen a film in VistaVision with Todd-AO sound. They have seen a dramatic historical film produced by the finest talent of Paramount Pictures Corporation and skillfully directed by George Seaton.

These visitors have had the choice of two showtimes provided by identical theaters showing the film on staggered schedules from a single projection booth. This modern projection booth has been visited by many SMPTE members.

Many are familiar with Colonial Williamsburg and know it as the restored eighteenth-century capital of the Virginia colony. An important, though never very large city, Williamsburg at its peak of historical significance contained about two hundred buildings. In 1780, near the end of the Revolutionary War, the capital of the new Commonwealth of Virginia was moved to Richmond and, thereafter, for about 150 years, Williamsburg virtually stood still. In 1926 nearly 70 of the original buildings remained. The Reverend W. A. R. Goodwin, Rector of Williamsburg's Bruton Parish Church, was well aware of the historical significance of Williamsburg

First presented as an illustrated lecture at the Society's Convention in Lake Placid, N.Y., on October 4, 1955, by Arthur L. Smith, Audio-Visual Director, Colonial Williamsburg, Williamsburg, Va. Coauthor is Ben Schlanger, Consulting Architect, 200 Park Avenue South, New York 3.

Image on the screen of Colonial Williamsburg Theater. Normally the seats would not be illuminated when the picture is playing.

and he succeeded in interesting John D. Rockefeller, Jr., in what was to result in almost a complete restoration of the city. With great accuracy a center of American history has been re-created and year by year it assumes an increasing importance as a place where visitors can have a visual and spiritual glimpse of the roots of our democracy.

Along with the physical restoration of Williamsburg came the problem of its educational interpretation. A nonprofit controlling organization called Colonial Williamsburg commenced the serious task of exhibiting key buildings and shops. Costumed guides, carefully trained, provided an oral explanation. In 1948 a temporary information center was constructed. A constantly repeating program of slides and films was used to orient visitors and augment the guide service. After several years of operation, the great value of this type of orientation was clearly demonstrated and plans were sought for a permanent information center, and an improved program.

The committee, faced with the challenging task of improving the interpretative program, was charged with the responsibility of determining the most imaginative method which would be practical to operate. Almost every conceivable possibility was explored. Wide consultation provided a fund of ideas to be investigated.

In the course of events, a definition of the problem was agreed upon. The purpose of the new program was "to orient the visitor in terms of *historical background* and *mood*." The word "mood" is responsible more than anything else for the final plans. At an early stage of the project a suggestion had been made to utilize a series of connecting rooms, with varying audio-visual shows, as a kind of historical *decompression* chamber. For various reasons this procedure was not practical. But it did serve to emphasize the need to take the audience back in *time*. How could an audience be given such an illusion? It seemed evident that some type of motion-picture experience might be the answer.

At this point, Max Abramovitz, architectural consultant for the project, recommended that Ben Schlanger, well-known theater architect, be consulted. This began a very happy relationship. For many years, Mr. Schlanger had been advocating an improved screen ratio, increased resolution by greater film area, brighter pictures on unmasked screens, and theater designs which were devoid of architectural decoration. This type of thinking was ideally suited to the Williamsburg project.

It was agreed that a wide-screen participation type of show was the best solution.

After considerable search for a suitable large-film process, the final decision was made easier by an offer on the part of Paramount Pictures Corp. to collaborate on a production using their VistaVision process. Todd-AO agreed to supply six-track stereophonic sound.

With the film medium determined, architect Ben Schlanger continued his research and soon he boldly suggested that Colonial Williamsburg construct two theaters. This proposal was made on two bases: (1) since the length of the film was to be 40 minutes, two theaters operated on a staggered schedule would reduce the maximum waiting time to 20 minutes; and (2) only the "cream" of the participation area in front of the large screen would need to be used for viewing.

Using a picture width of 52 ft (by 26 ft high) the seating was limited to eight rows of thirty seats each.

Architectural details of the Williamsburg theaters are given by Mr. Schlanger in the following paper. Nevertheless, it would be impossible to continue the non-architectural description of this Williamsburg project without reference to Mr. Schlanger's contributions in many areas. It was Mr. Schlanger who from the outset insisted that, properly, the conception of a film, its production and its exhibition are all one continuous and related process. (A list of some *Journal* contributions by Mr. Schlanger appears at the end of this part of the paper.)

Investigations in the area of wide-screen participation viewing and listening were extremely thorough and detailed. They ranged from the psychological implications of audience involvement through optics and acoustics, to the finer points of stereophony. The acknowledgments at the end of this paper give only the general idea of the wealth of important contributions to the technical thinking of the Williamsburg project.

With the general concept of twin theaters accepted, the next step was to determine the technical and artistic nature of the production to be exhibited. In consideration of the wide-screen image, all of the pros and cons of peripheral impressions were examined with care. One of the conclusions was a recommendation that a single lens and no close-ups be employed in the photography. (As a matter of record, the majority of scenes in the final film were taken within a very short range of lenses and there were no real close-ups.) The changing nature of perspective where the focal length of taking lenses varied widely was felt to be undesirable and unnatural. Duplication of natural vision was to be desired.

Some of the most fascinating planning sessions took place when stereophonic sound was discussed. For instance, a serious attempt was made to find a workable means of recording location sound stereophonically; it was finally decided that with normal screen action and editing it was impractical to record multiple-channel location sound. A technique of "swinging" sound from voice and effects tracks was later employed in mixing the sound. Music, of course, was truly stereophonic.

A proposal was seriously considered whereby a "presence" track would activate the entire seating area of a floating auditorium by means of converting audio energy to mechanical energy, feeding hydraulic springs. The idea was abandoned, not for lack of courage, but because it was felt that the effect would be distracting in terms of audience awareness.

Acoustics

The number and placement of horns to secure the effective distribution of sound was the subject of many planning sessions. The possibilities of left and right off-screen speakers, rear speakers, floor speakers and ceiling speakers were explored. Full sound awareness via a complete perimeter of electrostatic speakers was reluctantly abandoned when the sound quality of such speakers was studied.

With six tracks available, the final decision sent five of these to behind-the-screen speakers while the sixth fed a nest of six distributed ceiling speakers.

It was felt that the theater should be acoustically dead, making possible good exterior sound scenes. A well-known authority on acoustics, Leo Beranek explains this as follows: "The reason that the theater should be acoustically dead is that the illusion of creating out-

door conditions cannot be achieved where there is any reverberation or echo. When one walks outdoors, sounds that are generated travel directly to the listener unenhanced by room reflections. Thus, man has associated a feeling of openness with lack of reverberation. It is easy, however, to introduce reverberation into the soundtrack for those cases where specific room effects are desired. Another reason for introducing room effects into sound channels is the great variety of room conditions that Colonial Williamsburg might wish to depict in the film. These conditions would range from the reverberant acoustics of the House of Burgesses down to the nonreverberant conditions of a small bedchamber."

As constructed, the Williamsburg twin theaters have a reverberation time in the midfrequency range of 0.6 sec while in the high and low ranges this figure is slightly less. All floor areas are heavily carpeted.

Film Production

Development of a script was first commissioned by Paramount to the late James Agee who completed most of a treatment prior to his death. This last work of Mr. Agee was a document of great value and sensitivity—but because further detailing was needed, this work was postponed for later sympathetic completion.

The story of the film covers the years immediately preceding the American Revolution and in so doing vividly peoples the Williamsburg set in such a manner that visitors, having seen the film, may imagine that they walk the streets of the old city and visit the buildings.

Due to the intimacy of the theater, the amount of camera movement was extremely limited and the screen figures were kept low in the composition wherever possible. A six foot model of the theaters was demonstrated to the production crew before filming commenced so that the later visual effect of the screen would be realized. The large screen so close to the audience is a definite restriction as far as conventional photography is concerned. (This is an increasing problem as screens in theaters grow larger.)

The Paramount crew shot the film entirely on location in Williamsburg and on surrounding plantations. Extremely difficult interiors were actually filmed in the historic rooms, many of them small in size, and all of them small in terms of the usual set. Since the story concerned the years just prior to the American Revolution, the film was a costume piece. Every detail was handled with the greatest possible authenticity. Actors who played Washington, Jefferson, Patrick Henry, George Wythe and other historic characters were carefully selected for physical resemblances and also for voices to the extent we know about them.

The film, shot with Eastman Color Negative on double-frame VistaVision, is projected with the maximum possible lateral aperture. A small amount of top and bottom picture is lost to sound striping. A diagram of the film dimensions is shown in the succeeding paper.

Theater Construction

During production of the film, the construction of the theater was proceeding. Altec Lansing Corp. supplied the principal electronic work; Century Projector Co. manufactured the projectors.

The twin theaters are a part of the Information Center Building. A common projection booth serving both theaters is located over the main information and exhibition lobby. The audience enters the theater on one side and departs on the other. No center aisles are required but comfortable walking room is allowed by spacing rows of seats four feet apart. Persons in one row do not see those in other rows in front of them.

In order to achieve good visibility, yet prevent excessive keystoning, a stadium type of row elevation has been employed. Projection angle is about 4°.

Mr. Schlanger's theory that a motion-picture theater should be a neutral viewing area has been carried out completely in the new Williamsburg theaters. His desire to use a maskless screen and a blended lateral image required considerable technical investigation. The detailed description of the screen is given in the succeeding paper.

The projection booth has been regarded by projection specialists as an accomplishment of some merit. Although the fundamental layout, as shown in the following paper, was designed by Mr. Schlanger and the author, it represents, as is the case of the other areas, the design talents of many people.

The booth is serviced under a contract which includes the care of the mechanical functions and is perhaps unusual in this respect.

The day-to-day operation of this booth has been extremely satisfactory during the years of its operation. Only normal problems of wear and failure have been encountered though it is true that many of the special innovations required careful adjustment until operational experience was gained. Operators find the area pleasant, roomy and quiet.

Acknowledgments

The author gratefully acknowledges the assistance given at all stages of planning and construction. Among those who have made important contributions to the success of the project are the following: Brian O'Brien, American Optical Co.; Douglas Shearer, Metro-Goldwyn-Mayer; Walter R. Hicks, Reevesound Co.; Loren L. Ryder, Ryder Sound Services, Inc.; Charles R. Daily, then of Paramount Pictures Corp. and now of Hughes Aircraft Co.; Frank LeGrande, Paramount Pictures Corp.; Fred Hynes, Todd-AO; Edward S. Seeley, Altec Lansing Corp.; C. S. Perkins, Altec Lansing Corp.; Dave Demarest, Altec Lansing Corp.; Leo Beranek, Bolt, Beranek and Newman Inc.; Ernest Wolf, Wellesley College; W. J. Crozier, Harvard University; Larry Davies, Century Projector Co.; W. Ferguson, New York University; C. S. Ashcraft, C. S. Ashcraft Mfg. Company, Inc.; Willard Yoder, W. A. Yoder Co.; Daniel J. Bloomberg, Republic Studios; John Selby, Selby Industries, Inc.; Leonard Satz, Technikote Corp.; F. B. Hutchinson, Perkin-Elmer Corp.

Motion-Picture System From Camera to Viewer

By BEN SCHLANGER

THE PROPOSAL FOR a very special type of motion-picture presentation for Colonial Williamsburg specified a practical and economical system that would be able to project an illusion of reality beyond that of a conventional "movie." The effect, as nearly as possible, would be that of living re-enactment of events just prior to the American Revolution. Also the presentation to the visitor to Colonial Williamsburg had to be unusual, differing from all of the comparatively new types of film projection being introduced at about the time this program was started. If Cinerama, CinemaScope or even just the most modest wide-screen developments, all comparatively new at the time, could have been exclusively used by Colonial Williamsburg the problem might readily and quickly have been solved. But we had to have something more than any of these systems could achieve and we had to accomplish it without any radical changes in any of the equipment, optics, or film developed to this time. We chose to use available equipments and processes in a new way to take advantage of this unique opportunity. Our goal was to build a theater and to produce a film, using the greater film area per frame available, that would enable the viewer to feel that he was "at the scene" and participating in the events shown on the screen.

For this "illusion of reality" it is necessary to have "picture dominance," sufficient resolution of photographic detail and a suitable cinematographic technique. The first reaction to these specifications from the motion-picture industry was discouraging, the general attitude being that it was too much to expect that a motion-picture film could be made to be shown only in a specific theater or that a theater could be specially designed for a given film. The Colonial Williamsburg project was to be the first example of such a coordinated and related procedure to achieve this end result. In Colonial Williams-

A contribution by Ben Schlanger, Consulting Architect, 200 Park Avenue South, New York 3, received March 6, 1961.

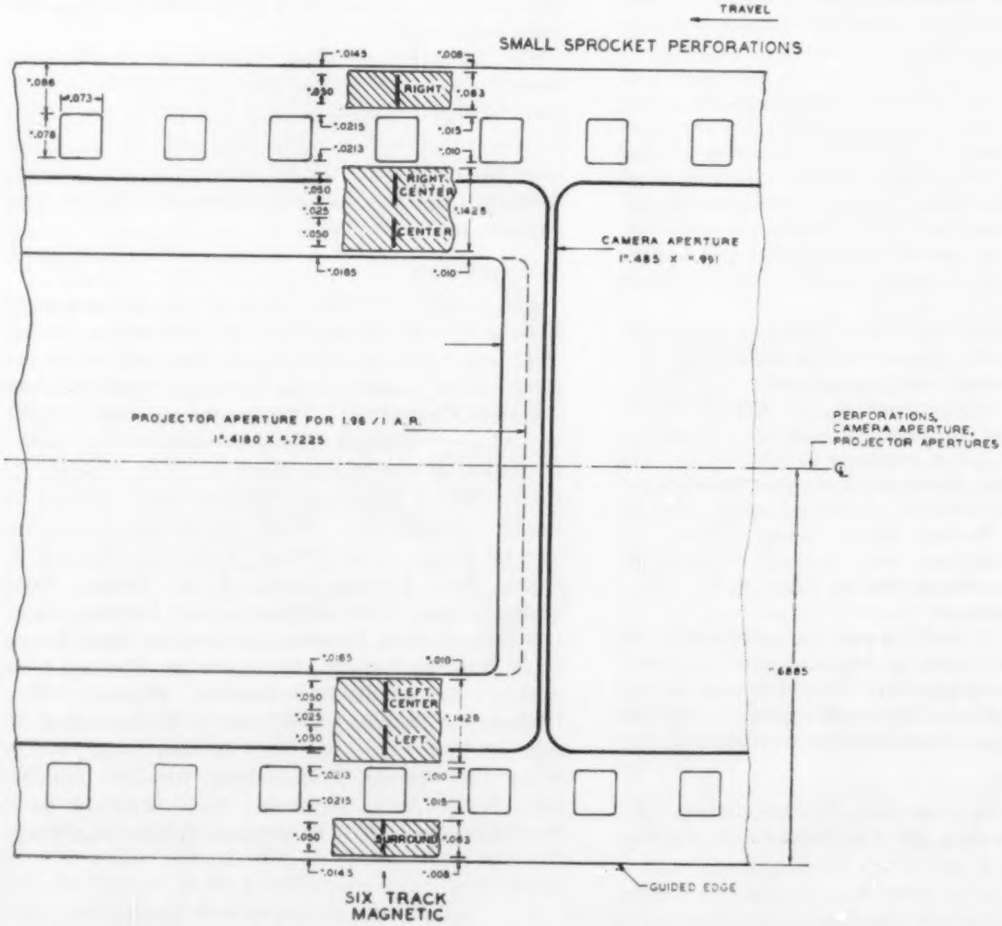

Fig. 1. Magnetic track positions for six channel sound on horizontal VistaVision prints. (Courtesy of Paramount Pictures Corp.)

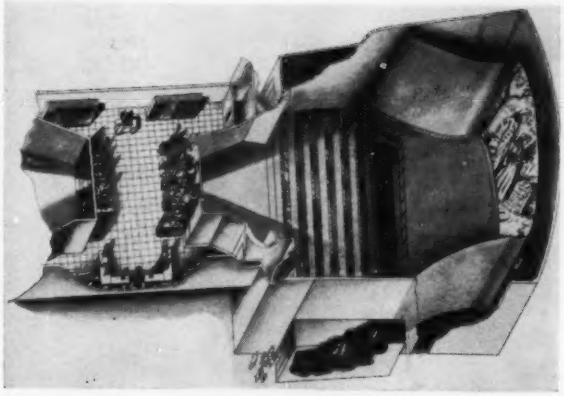

Fig. 2. Isometric drawing of Williamsburg Information Center Theaters. Note entrance area at bottom functions as light lock. Light level adaptation can occur in this passage.

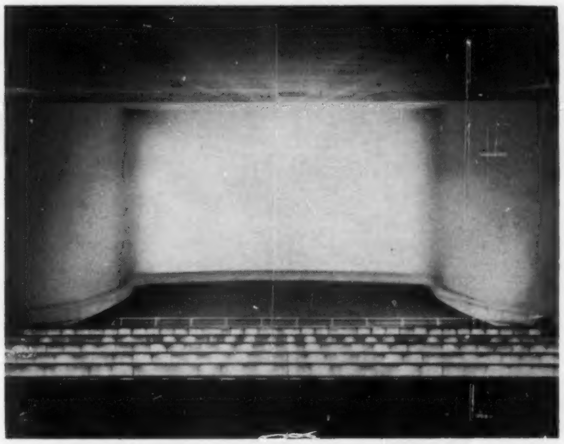

Fig. 3. The theater seen from the rear shows the illuminated barrier walls and the curvature of the screen.

burg we found the first opportunity to plan the theater and the film to be shown in the theater and to profit thereby from all of the advantages presented by this combined effort.

Frame Area and Seating Capacity

The availability of a film area per frame greater than the amount obtainable with standard 35mm projection was the first requirement in this project. The film dimensions for the VistaVision frame are shown in Fig. 1. It should be noted that by using the small perforations, six 50-mil soundtracks, one each outside and two inside, are available and since these are running at 180 ft/min, rather than the usual 90 ft/min, a 100-mil track equivalent (to single-frame sound) is obtained.

With this new film presentation technique there is a definite relationship between the film area per frame and the possible seating capacity of the theater auditorium. The film area per frame of standard 35mm projection would have yielded insufficient seating capacity.

Seating capacity is determined in this case by the minimum and maximum viewing distances and the width of the viewing pattern. In turn these dimensions are determined by the size of the projected picture which in turn is determined by the film area per frame, the projection optics and the projection light available. The horizontal VistaVision projection system used in this project made it possible to project a picture of good quality 52 ft wide and 26 ft high which could be viewed from a distance of 33 ft or more without revealing film grain or fuzz. The bottom of the projected picture was placed at a level approximately even with the floor under the first row of seats so that the top of the picture would not be unnaturally high for the first row of seats and yet high enough so that the top edge is not too easily visible to any of the entire audience.

The vertical and horizontal range of vision was studied to aid in determining the proper position for the top of the projected picture and the maximum viewing distance, limited by the vertical and horizontal angles within which one could see without being aware of head or eye movement. This range was selected as the range within which most of our visual experience time is found. The horizontal range was found to be approximately 60° and the vertical range about 15° above the true horizontal level. The "picture dominance" effect is possible when the top margin and side margins of the projected picture are positioned so as to fill the whole range of vision described by these angles. This in turn enables the viewers to have the walls and ceiling of the auditorium enclosure beyond their easy range of vision, and usually when the viewer is concentrating on the performance the head does not turn to see beyond the picture area.

The Screen

Some detailed consideration may now be given to the screen before describing the viewing area and the projection facilities.

The giant 120-ft screens are the result of considerable original research by the authors of these papers who tested almost every known screen material with many variations of surface and gain in an attempt to find a material which would have the desired amount of reflectance and which, in the extensive and curved surround portions, would be properly sympathetic in reaction to reflections from the projected image area. Embossed screens were of particular interest but none of these could handle the light perfectly throughout the entire curvature of the screen. As a matter of fact, neither could the standard aluminized surfaces until graded spraying was introduced.

The projection area extends from floor to ceiling; therefore the screen must extend beyond these extremes. Without the elimination of the vertical supports, it would be necessary to thread the huge one-piece screen between the upright members—a procedure which probably would have distorted the flexible plastic. With a frame devoid of vertical supports, the actual installation was accomplished in less than six hours.

As may be seen in Figs. 2 and 3 the curvature of the screen was to be complex, probably more complex than any ever attempted elsewhere. It is two modified S curves and there was considerable doubt that a screen could be hung in this manner without wrinkles and extensive bellying; however full-scale tests engineered by Selby Industries at Cleveland demonstrated the feasibility of the idea.

In the final installation the screen was stretched on a pipe frame that threaded through adjustable brackets, thereby permitting the desired curvatures. No vertical

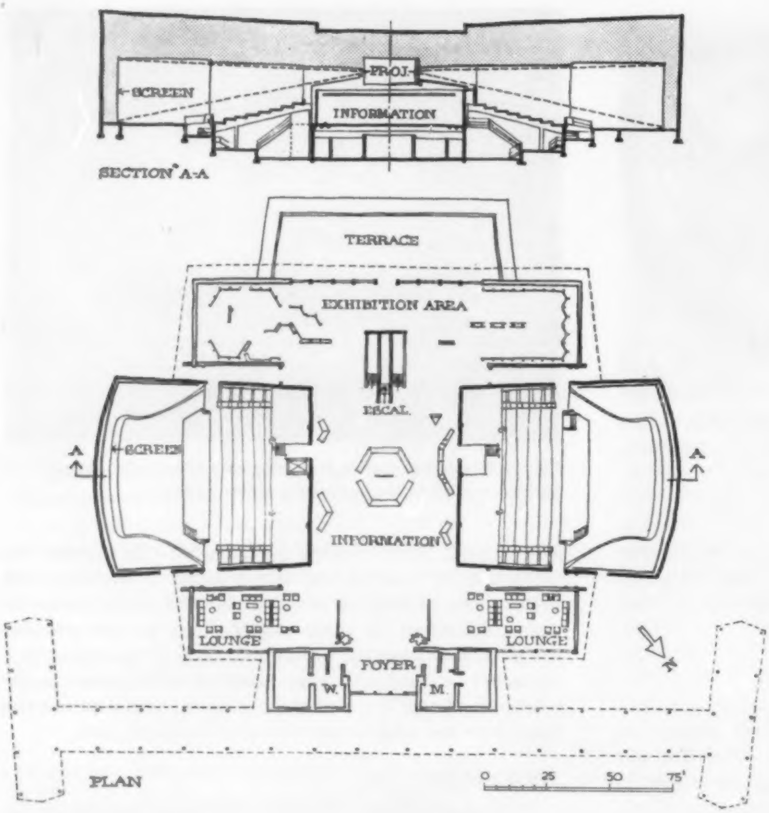

Fig. 4. Plan of theater. (Courtesy of Architectural Forum.)

members were used in the frame. The top brackets were fastened to the ceiling and the bottom ones to the floor. This was highly desirable because the screen, being higher than the ceiling, had to be unrolled from the back.

Although the screen image was to extend to the full screen height of 26 ft, the horizontal measurement was to be only 52 ft at which point it was to blend into a continuing screen surface surround. The blend was accomplished initially by having the outer rays of the projected image meet the screen at its point of greatest curvature.

However, the print of the transition and surround area proved to be too reflective when coated with 1.7 gain necessary for the image area. Blended spraying reduced the surround gain to a desired 1.3 and this proved to be quite satisfactory.

A maintenance procedure which may prove of interest to others is the practice of removing dust accumulations on this large screen by means of hand rollers covered with soft, disposable felt.

Design of the Viewing Spaces

The 60° horizontal range dictated a maximum viewing distance of about 61 ft which permitted eight rows of seats liberally spaced at a distance of 4 ft. The very low position of the bottom of the picture also made it appear that the picture filled all visible space. The liberal row spacing was needed to permit quick ingress and egress for the continuous change of audience every 40 minutes. With all of these requirements we were able to develop 240 seats in the seating pattern, restricting the width of the pattern to about 5 ft greater width than the projected picture, and so avoid a distorted view of the image from extreme side seats.

The number of visitors anticipated for the performance was calculated to be 500 every 40 minutes or 500 per showing of a 40-minute film. This requirement had indicated the need for two separate viewing spaces and this duplication was readily accepted because it also made it possible to stagger the starting times of the showings so that a showing could start every 20 minutes. As Fig. 4 indicates, a single projection room was placed between the two viewing spaces with a complete set of projectors for each screen of each viewing space. To provide sufficient projection distance for a 52-ft projected picture and yet be able to use an acceptable projection lens it was necessary to increase the projection from the screen to a point beyond that which would otherwise have been suggested by the position of the row furthest from the screen. This requirement increased the total length of the structure with the resultant extra space being used for a much needed foyer and exhibition area under the viewing spaces.

As noted above these viewing spaces are designed for films made specifically for showing in these viewing spaces and in none other. For example, because the projected picture is so large for the dimensions of the viewing pattern it becomes unnecessary to use more than one focal length for the cinematography. Short focal length lenses producing the so-called close-up shot are deliberately avoided because satisfactory visual acuity is assured with the limited viewing distances. Also, the figures of people and objects are kept in a relatively lower and more natural position on the screen with a medium focal length lens. Another requirement is to keep figures of people and objects somewhat away from the top and the sides of the screen so as to provide a much needed peripheral area

Fig. 5. Eight rows of seats are separated by barrier walls.

Fig. 6. Continental seating and generous aisles are illuminated from below seats. Barrier walls between seats are also illuminated.

beyond the main points of interest of a given shot. Important detail is kept away from the marginal areas of the picture so that these areas can be used for a vignetting and blending of the picture into walls and ceiling contiguous and continuous to the screen. These transitional areas are seen only out of the corner of the eye because of the seating pattern design and the walls and ceiling are seen only if a viewer turns his head deliberately away from the normal viewing direction. Even if such an unusual turn of the head is made the blending of picture and picture surround is soft and not in any way distracting. This is accomplished by having the screen surface continue into the surround with the same color and texture as the screen and also by controlling the amount of light re-reflected from the screen from this surround area.

With the screen filling the entire space from floor to ceiling, no curtains or contrasting frame maskings are used. Instead of the usual structural walls on either side of the screen, the screen material itself continues to become the screen surround. There is no room for any artificial "picture-on-the-wall" effect. It is even possible for the viewer to become oblivious to the space enclosure where he is sitting as he becomes more absorbed in the screen. Another step toward bringing about the illusion of reality and heightening viewer participation was that of concealing the presence of other viewers and making sure that the traffic aisles would not be visible. Low walls were built to conceal other viewers while not obstructing the view of the projected picture, and traffic aisles along the extreme side seats are out of view (Figs. 5 and 6).

Each row of seats is elevated sufficiently above the preceding row to assure unobstructed vision of the projected picture over the low walls. The entrance and exit doors to the viewing spaces are located so that they do not appear within easy range of vision when the projected picture is on view. There are no secondary sources of light visible for room lighting during the picture projection period. Sufficient light for safety purposes comes from the screen itself and from low-level carpet lighting in the side aisles which does not show to the viewers' eyes. During the emptying and filling periods the viewing spaces are illuminated with an overall skydome effect by concealed flood light and concealed lighting within the low separating walls between the rows. These walls are plastic-lined perforated stainless steel to enhance the effect of floating in a uniform and evenly lighted space.

From these viewing spaces there is no way of measuring distance to the screen because there is no yardstick of visible people, furniture pieces or architectural elements or even differences of shading of light to serve as clues for sensing distance. This feeling carries into the picture projection period. Care was taken even in the selection of the texture of all surfaces to be sure that all light would reflect evenly from all surfaces.

Projection Booth

The basic size of the booth is 50 by 50 ft, but part of this is lost in front of the projection machinery where it becomes a "throat" into the theaters. It is large, clean, acoustically treated and air-conditioned (Figs. 7 and 8).

Four horizontal VistaVision projectors are the principal equipment in the booth, with two facing into each theater. In addition, each theater has a 16mm Eastman Model 25 Arc Projector and a double slide projector equipped with an optical dissolve mechanism. The VistaVision projectors are generally standard but do have some important modifications. Curved gates and larger intermittents and sprockets carry the film better. The Brush soundhead picks up the sound signal ahead of the picture. Special reels, 28 in. in diameter, carry the entire 37-minute show and require 30-in. magazines. Half-inch spindle shafts are used.

The relatively short projection throw required the use of a $2\frac{3}{4}$-in. lens and the Bausch & Lomb Super Cinephor which was chosen has been quite satisfactory. Optical problems resulting from the use of a short lens and a condensor-type lamp resulted in a shift to mirror-type lamps. The mirror-type lamp enabled an amperage reduction from 180 to 135 amps. Ashcraft lamps, modified slightly, produced a flatter field of better quality light. Three trims were obtainable from a carbon; instead of one, at 180 amps.

A design for maximum lamp to screen efficiency led to the elimination of glass in the booth portholes. Since the double-speed VistaVision projectors make more noise than the single-speed variety, it was necessary to design an acoustic hood for the area between the projector and the port. This was designed by the firm of Bolt, Beranek and Newman.

The projectors are powered by d-c generators and three 300-amp units are on call. When the lamphouses

Fig. 7. Each theater is equipped with two VistaVision projectors and one 16mm arc projector. Also available are 2 x 2 slide projectors and a standard 35mm projector.

Fig. 8. The rewinds in the foreground accommodate such large reels that special consideration was given to the torque problems of the rewind motors.

were changed from condenser-type to mirror-type and the power for each machine reduced to 135 amp, only one generator was necessary at a time and this has enabled the other units to be rotated and serviced for maximum efficiency.

The rewind area of the projection booth contains two torque-motor-driven rewinds. They are installed on low tables at which operators can sit comfortably during the rewind and inspection process. A Bell & Howell pedestal-type hot splicer is located midway between the two rewind tables.

The storage of the oversized reels of film was a problem which was nicely solved by placing them in slightly ramped compartments. When the narrow door of a compartment is dropped to become a supporting rest, the reel of film, via simple gravity, rolls forward to a cushioned stop and can be easily picked up by the operator and taken to the projector. The total weight of reel and film (6600 ft) is 42 lb.

All booth wiring is located in large accessible recessed floor and wall conduits. Of particular interest are the control stations provided conveniently beside each machine (Fig. 9). Within these control stations are housed complete master operations including:

(1) all necessary on-off switching,

(2) automatic segues from one sound source to another,

(3) a master up-down pushbutton set to control all lights,

(4) cue and voice signals from the stage area, and

(5) time clocks which reset by lever action.

Much of the automation included in the central controls is valued because it eliminates the human variation which occurs in such operations as manual fading. The motor-driven automatic segue takes place in about four to five seconds and provides a smooth transition blend of sound. Although the idea for this came from Mr. Smith, the actual design of the unit and other specialized Altec installations are to be credited to Dave Demarest of that firm.

Each theater has available a two-track Ampex stereophonic tape machine for intermission music and the sound output normally is fed to behind-the-screen speakers Nos. 1 and 5 (the outer units). The Ampex-type units can be started and stopped remotely at the central control station.

The control stations are important both in terms of innovations and logic. In the vast majority of theaters in operation today, control points tend to be scattered all over the booth. All too frequently intermission music is obtained from turntables and scratchy records. High-quality sound from tape is certainly better and seems to be appreciated by the audience.

Audio monitoring of the six-track film sound is also available when the operator is standing at the control station. Each track may, if desired, be monitored separately.

The main amplifier banks include spare circuits and plug-in components which enable rapid switchovers when trouble occurs.

Each of the two theaters contains a public address system which has amplifiers and speakers separate from the film sound equipment.

It may also be of interest that each theater was provided with a Budelman wireless microphone setup. It was

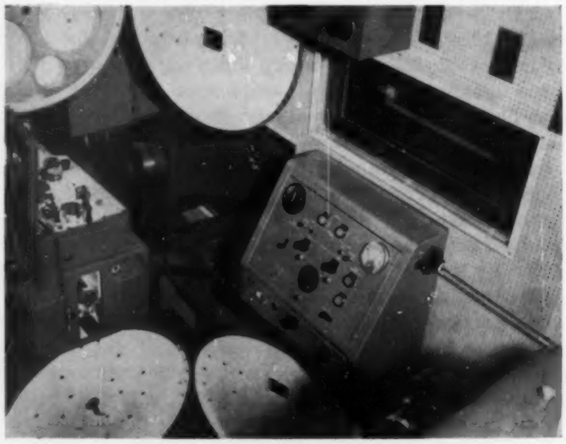

Fig. 9. The control stations beside each machine are thought to be unique. With the exception of firing the arc, all controls are at this station including remote stereo tape for intermission, motor start, master button for dimming circuits, automatic sound segue, program timing, stage communication, etc. To the left of the control station are the acoustic hoods which snug up against the projector when in use. This device permits glassless ports.

necessary to replace the antenna provided with a conical TV type in order to obtain best results.

Inasmuch as the theaters are used during the evening for presentation of special lectures, provision for the use of slides was necessary. Two Strong Arc Projectors with a dissolving mechanism and automatic picture feed were assembled by W. A. Yoder of Richmond, Virginia. The Ampex stereo machines, also supplied by Mr. Yoder, have a special provision whereby, when used to play a prerecorded talk on one track, can provide a signal from the other to activate the automatic feature of the slide projectors. Hence a complete show can be presented automatically and the frequency of slide changes need not be by fixed interval.

Outside of the entrance door of each theater is a time signal in minutes which shows the number of minutes before the next show begins. The starting digits can be dialed from the booth and clock action reduces the numbers.

Both entrance and exit doors operate automatically when patrons approach under-carpet switches.

Lighting

The theaters are equipped with complex automatic dimmer systems wherein different areas of lighting can be preset and the whole can be controlled by a single push-button located at control stations. There are "light adjustment locks" which the visitor passes through on his way from the brilliantly lit lobby to the theater interior, and these provide a partial adjustment in level. During the performance these are faded out. At present only two principal light sources are used for auditorium lighting. One is strip lighting beneath the seats which also illuminates the barrier walls between the rows. The second is screen floodlighting. The latter has available three primary colors plus white spotlighting where patterns may be projected. Rear cove lighting and ceiling spots are used on other-than-film occasions and panic lights are available for emergencies and cleaning.

Although this complete facility is used at one time or another, the standard choice for intermission screen lighting has been "unearthly" blue which suggests a mystic mood. Many people entering the theater for the first time see no screen at all — just a soft haze of blue light.

As the lights are dimmed, a film image appears and the audience is in a dense forest. Only the sound of twittering birds is heard. The camera dollies towards a small bright opening through the trees and as the bright image grows larger and larger it reaches the full 52-ft size—an awe-inspiring sight.

No titles or credits are projected on the screen. These are shown in an illuminated showcase permanently located in the lobby.

Conclusion

The desire in the designing was to permit the viewer to the fullest possible extent to be able to transport himself in imagination to a different time and space by furnishing a floating void or optical vacuum to provide the transition to the new time and space and to hold him there by eliminating all distractions. The name *Transcenium* suggests itself for this type of presentation. Long light locks having intermediate light levels serve as a transition from conditions of the outer foyers to the special spacial effect of the viewing enclosures.

Larger seating capacities are possible with this type of presentation by using still greater film area and using a less commodious seat row spacing. It would be possible to project a good-quality picture 63 ft wide with 70mm film and thereby provide about 400 seats on either side of one projection room. The combined seating capacity of 800 seats for such a transcenium presentation would, it is believed, bring a fuller enjoyment to more film fans.

Energy Absorption Considerations in Motion-Picture Projection

By ERIC A. YAVITZ

Data on the energy absorption characteristics of color and black-and-white release films are presented. Calculations are made of the relative energy absorbed by these films when projected with a high-intensity carbon arc in conjunction with a silver or dichroic reflector. The results are compared and their significance and implications are discussed. The spectral distribution of the incident energy and its important bearing upon the performance of color films are reviewed.

INTRODUCTION

Recent years have seen a more widespread use of color films and a trend toward higher flux intensities in modern projection equipment. As a result, there is increased interest in comparing the projection behavior of color films to that of black-and-white films under these higher thermal stresses. As a tool in studying the thermal behavior of all films, it is important to know the relative amount of energy absorbed by them during projection, and the spectral region within which this absorbed energy lies. To provide this type of information, spectral transmittance data were obtained for two types of color and one type of black-and-white release print film. Combining these data and the data for the spectral emission of a high-intensity carbon arc, a series of calculations was made to determine the relative energy absorbed by these films when they are subjected to arc radiation. The calculations were made for arc energy reflected by a silver reflector and by a dichroic ("cold") reflector, since these represent projection systems which are in widespread current commerical use. The results of the calculations are presented below, along with a discussion of what they imply, both in comparing black-and-white to color films, and silver to dichroic reflectors.

Presented on May 9, 1961, at the Society's Convention in Toronto, by Eric A. Yavitz, Manufacturing Experiments Div., Kodak Park Works, Eastman Kodak Co., Rochester 4, N.Y.
(This paper was received on June 19, 1961.)

ASSUMPTIONS AND LIMITATIONS

Almost the entire energy emitted by the high-intensity carbon arc lies in the visible and near-infrared regions of the spectrum. Since both the emission of the arc and the reflectance of the mirrors are relatively small above 3.0 microns, the calculations are limited to the spectral region from 0.4 to 3.0 μ. This range is considered adequate for practical interpretation of the data available. The small amount of ultraviolet energy emitted by the arc is not included in the calculation.

The spectral transmittance characteristics and the results derived from them pertain to films flashed and processed to a high integral visual density (Eastman Color Print Film, Type 5382, visual density 3.4; Technicolor Print Film, visual density 2.6; and Eastman Fine Grain Release Positive Film, Type 5302 — black-and-white film —, visual density 2.66).* An average scene will normally include a wide range of densities, so that the energy absorption computed here will be greater than would normally be encountered in projecting a release print. These high density values, however, are useful in making a comparison of the energy absorbed by various films when they are projected in conjunction with different reflectors. Since this paper is concerned with relative rather than absolute energy absorption, this sort of a comparison is more useful and less limited in concept than treating films of "average" density.

* The visual densities reported here are those of the flashed samples which were available for measurement. They are by no means the maximum densities of the films.

Black-and-white film was assumed wholly opaque throughout the spectral range considered. Figure 1 shows that the film exhibits essentially zero transmittance up to 4.3 μ and very little transmittance (up to 6%) beyond that. Since the energy incident on the film is considered negligible beyond 3.0 μ, the high-density black-and-white film may reasonably be considered to absorb all the arc energy which falls on it.

In the presentation and discussion of results below, the spectral range under consideration is treated in two discrete subdivisions: visible range, 0.4–0.7 μ, and infrared range, 0.7–3.0 μ. While the results are reported as integral values for the entire spectral range of each of these subdivisions, the calculations were performed in a differential (wavelength by wavelength) manner for greater accuracy.

Reflection of energy at the film surfaces has not been considered in the calculations. Since this reflection is essentially the same for all the films discussed, and this discussion is comparative rather than absolute, the omission of this factor is justifiable.

RESULTS

Arc Emission

The high-intensity carbon arc crater emits energy whose spectral distribution is represented in Fig. 2. (This plot is based on National Carbon Co. data[1] out to 3.0 μ, and extrapolated to 5.0 μ by data for a black-body radiator at 4000 K.)

In the range under consideration (0.4 to 3.0 μ), the high-intensity carbon arc emits 35.0% of its radiation in the visible range and 65.0% in the infrared.

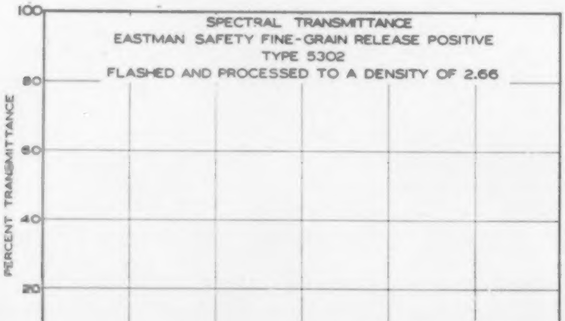

Figure 1

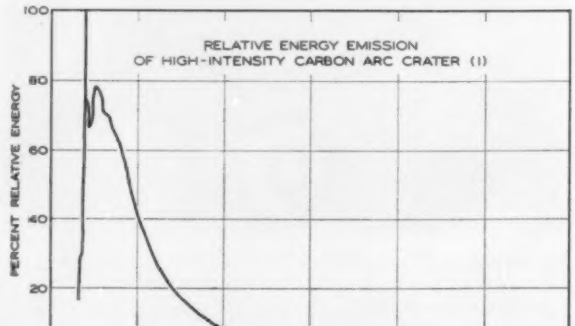

Figure 2

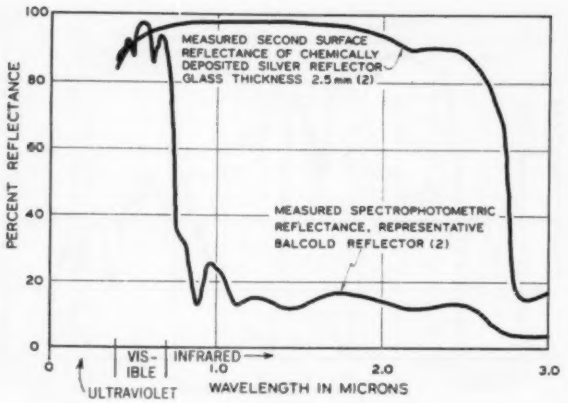

Figure 3

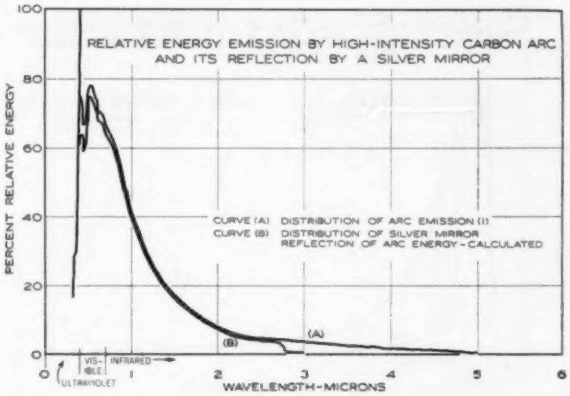

Figure 4

Silver Mirror

The silver-coated mirror (Fig. 3) reflects a high percentage of the energy which strikes it. The silver reflector returns 91.5% of the visible and 95.5% of the infrared energy which it collects. This reflection amounts to 94.1% of the total arc radiation. Since the reflectance of the silver mirror in the visible and infrared regions is not substantially different, there is no substantial shift in the spectral distribution of the energy incident on the film from that emitted by the arc (Fig. 4).

The spectral transmittance characteristics of the high-visual-density Eastman Color Print Film, Type 5382, are such that the film absorbs essentially all the visible energy and 26.0% of any infrared energy incident on it in the spectral range considered. Therefore, when this film is exposed to arc radiation reflected by a silver mirror, it will absorb 91.5% of the visible and 24.8% of the infrared energy originally striking the mirror. Overall, then, this film absorbs 48.1% of the total arc energy collected by the silver reflector.

The high-density Technicolor Print Film also absorbs essentially all visible energy incident on it, but only 19.6% of any infrared. When subjected to arc radiation in a silver reflector system, this film will absorb 91.5% of the visible and 18.7% of the infrared, or 44.1% of the total energy collected by the reflector.

The high-density Eastman Fine Grain Release Positive Film, Type 5302, is essentially opaque at all wavelengths in the range under consideration. In a silver reflector lamphouse, then, this film will absorb 91.5% of the visible and 95.5% of the infrared, or 94.1% of the total radiation collected by the reflector. This absorption is equivalent to all the energy which is reflected onto the film by the silver mirror.

Dichroic Mirror

A "cold" reflector, such as the Bausch & Lomb Balcold Reflector,[2] is coated with a dichroic interference coating and reflects the arc radiation selectively, as shown in Figs. 3 and 5. The dichroic coating is designed to minimize reflection of infrared energy without substantially affecting the visible range reflectance of the mirror.

The typical Balcold mirror effectively reflects 91.5% of the visible and 22.7% of the infrared energy which strikes it. The total radiation reflected by this mirror is therefore 46.8% of that emitted by the arc. The energy that reaches the film from this reflector is 68.4% in the visible range and 31.6% in the infrared. Because the reflectance of this mirror is much higher in the visible than in the infrared region, there is now a shift in the spectral distribution of the energy which is reflected onto the film. Whereas the original arc emission and the energy reflected by the silver mirror contain about one-third visible energy, the dichroic mirror reflection of the same arc emission will contain about two-thirds visible energy. This shift in the energy distribution is an important factor and will be further discussed below.

The spectral transmittance of the various films is, of course, an inherent property and remains unchanged. When projected in a dichroic mirror system, however, owing to the different amount and distribution of energy to which they are exposed, the films will absorb a different amount of energy than they do from a silver mirror. Eastman Color Print Film, Type 5382, absorbs 91.5% of the visible and 5.9% of the infrared, or 35.8% of the total energy striking the reflector. Technicolor Print Film absorbs 91.5% of the visible and 4.5% of the infrared, or 34.9% of the total energy which the reflector originally collects.

Again, Type 5302 absorbs all the energy incident on it. In this case, it is the total energy reflected by the dichroic mirror which, as calculated above, is 46.8% of the total arc emission which the reflector collects. The results are summarized and tabulated for easier reference in Table I.

Distribution of Absorbed Energy

The distribution of energy which a particular film absorbs is of considerable interest. Since energy in the visible range is necessary to project the film image on the screen, the heat evolved from the absorption of this energy must be tolerated. On the other hand, since

Table I. Energy Absorbed by Type 5302, 5382 and Technicolor Films, High Visual Density.

	5302	5382	Technicolor
Image Properties*			
Absorption, visible, %	100	100	100
Absorption, infrared to 3.0 μ, %	100	26.0	19.6
In Silver Reflector System†			
Absorption, visible, %	91.5	91.5	91.5
Absorption, infrared, %	95.5	24.8	18.7
Absorption, % of total	94.1	48.1	44.1
Fraction of film temperature rise			
caused by visible, %	34.0	66.5	72.6
caused by infrared, %	66.0	33.5	27.4
In Dichroic Reflector System†			
Absorption, visible, %	91.5	91.5	91.5
Absorption, infrared, %	22.7	5.9	4.5
Absorption, % of total	46.8	35.8	34.9
Fraction of film temperature rise			
caused by visible, %	68.4	89.4	91.8
caused by infrared, %	31.6	10.6	8.2

* Basis: incident arc energy.
† Basis: arc energy collected by the reflector.

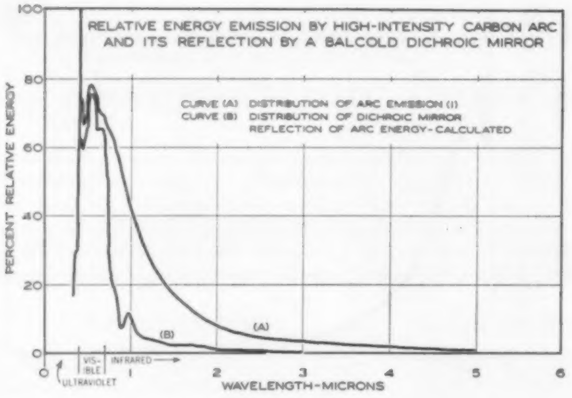

Figure 5

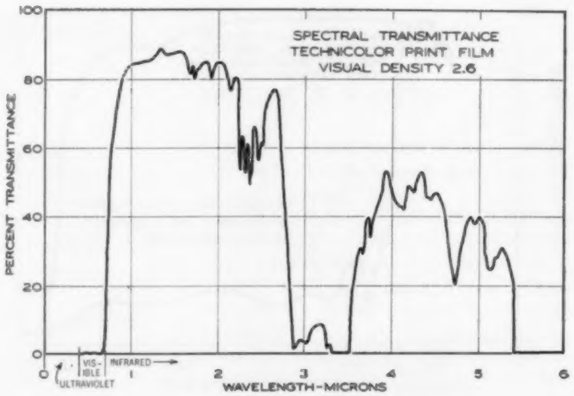

Figure 6

infrared energy contributes nothing to the screen image, it is desirable to minimize absorption of such energy as much as possible. The absorbed energy distribution for each film is presented in Table I. The table points out the proportion of temperature rise in the films which is caused by the absorption of energy in the visible (useful) and the infrared (useless) range. It will be noted that in a silver reflector system, roughly two-thirds of the energy absorbed by Type 5302, and one-third of the energy absorbed by the color films is in the undesirable infrared range. In the dichroic reflector system, these undesirable portions are decreased to approximately 30% for the black-and-white and 10% for the color films.

DISCUSSION

Energy Absorption Differences Between Color and Black-and-White Films

A common way of measuring flux incident on film in the gate of a projector is by means of a flux radiation meter which indicates only the *total* incident flux, and does not take account of its spectral distribution. In the consideration of thermal problems, however, this spectral distribution is very important, particularly in the projection of color films. The two color films considered here show very little difference in energy absorption characteristics between themselves. However, a fundamental difference in transmission characteristics exists between them and black-and-white films at varying visual densities. Whereas the near-infrared density of the silver image of black-and-white film varies with its visual density,[3] that of the dye image of color films remains essentially constant beyond 1 μ, regardless of visual density. Comparison of the transmittance curves for the color films (Figs. 6–8) to that of clear film base (Fig. 9) shows that the color film dyes, regardless of visual density, do not greatly affect the infrared transmission of the clear film base much beyond the visible range. (The difference between the actual transmittance of the clear film and 100% transmittance is largely explained by reflection losses at the two film-air interfaces.) Generally, then, color films are more transparent to infrared than black-and-white ones. The difference becomes greater with increasing visual density.

Black-and-white films absorb energy in an essentially nonselective manner throughout the spectral range under consideration. As a result, the distribution of the incident energy does not affect the amount of energy absorbed. Color films, however, show a selective absorption and will generally be more opaque in the visible than in the infrared range. Because of this selective absorption, color films absorb a different amount of energy in a dichroic reflector system than they do in a silver reflector system, solely as a result of the difference in the distribution of the reflected energy. This is quite apart from any effect which may be due to the difference in the total flux which the two systems reflect onto the film.

Energy Absorption at Constant Total Flux

The dichroic reflector is a relatively recent commercial development which is designed to minimize the infrared radiation incident on the film and thus provide for cooler projection at a *given level of screen brightness* (see below). In some test applications, it may be necessary to interchange silver and dichroic reflectors and maintain control of constant total flux by means of a flux radiation meter. This interchange of mirrors at a constant flux would not be encountered in normal theatrical projection, since in order to bring it about one must either increase the carbon arc wattage for the dichroic mirror, or lessen the energy reflected from the silver mirror by inserting a screen in the light beam. However, in some special test cases, a constant flux interchange of mirrors is desirable and

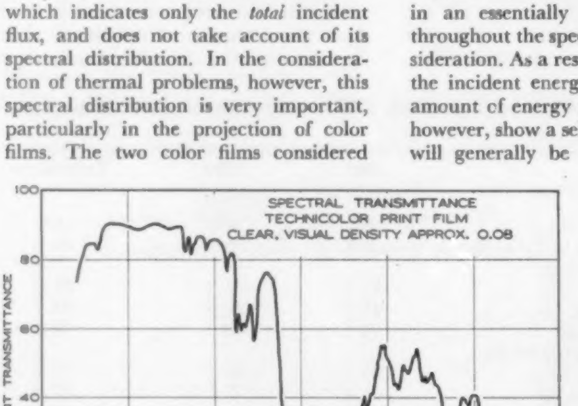

Figure 7

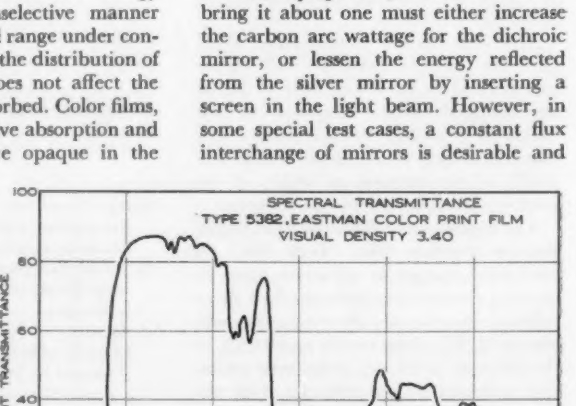

Figure 8

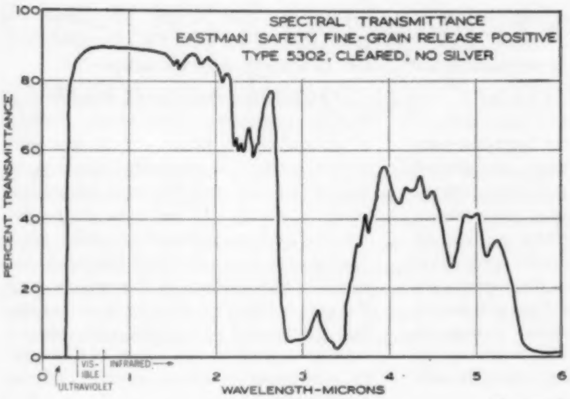

Figure 9

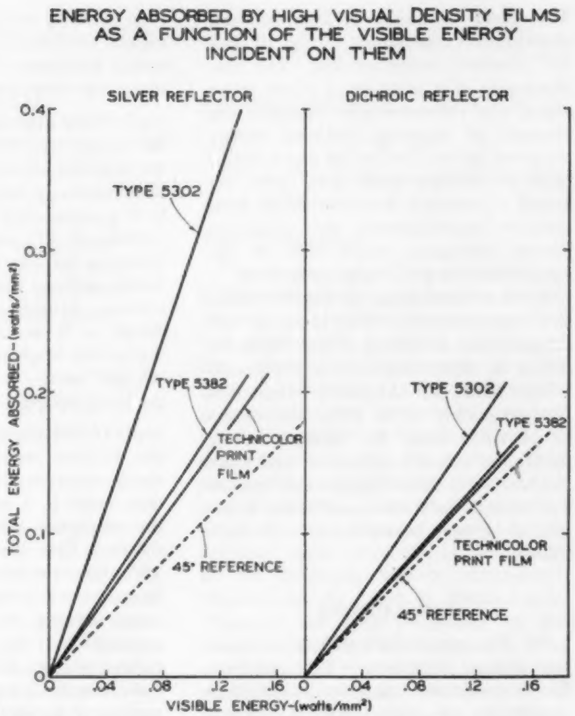

Figure 10

can thus be artificially produced. Such cases require particular attention and illustrate the necessity of accounting for energy distribution. The greater portion of a dichroic mirror's reflected energy is in the visible range. At a given level of total flux, therefore, a dichroic mirror will reflect about twice as much visible energy as a silver mirror. This increased proportion of visible energy, combined with the fact that the color films show their major absorption in the visible range, results in color films absorbing more energy and actually running hotter with a dichroic mirror than a silver mirror *at equal total flux*. A calculation of energy absorption, using the data presented in this paper for high visual density films, may illustrate this point.

A calculation of energy for a flux radiation meter reading of 0.30 w/mm² at the aperture (representing the total energy incident on the film) is presented in Table II.

From this example, it is evident that when the color films are subjected to *the same total flux* reflected by a silver or a dichroic mirror, they will absorb approximately 50% more energy in the dichroic reflector system. Further examination of this example shows that this increase is due entirely to the higher proportion of visible energy that is reflected on the film by the dichroic reflector.

This computation indicates that care must be taken when measuring flux with a radiation meter and correlating these measurements with heat absorption, particularly in the projection of color films. It is important to remember that not only the intensity of the flux at the aperture but its spectral distribution as well affects the thermal problem in projection.

Energy Absorption at Constant Screen Brightness

A major purpose of modern projection equipment is the delivery of maximum light on the screen with a minimum of heat on the film. Except in controlled test work where a constant flux level is desired, the consideration of heat absorption at a constant level of screen brightness is of a more practical nature. This is the condition which is encountered in theatrical projection when a silver reflector is interchanged with a dichroic reflector without any other changes being made in the projection system.

Since the reflectance of both the silver and the dichroic mirror is approximately the same in the visible range of the spectrum, interchanging the mirrors will not alter the reflection of visible energy, and the screen brightness will remain essentially constant when the same arc is used in conjunction with a silver or a dichroic reflector. It is in this consideration that the advantages of the dichroic reflector are realized.

The level of screen brightness is, of course, a function of the visible energy only.† In minimizing infrared reflection, therefore, the dichroic reflector imposes less heat on the film than a silver reflector for the same level of screen brightness. For example, a dichroic mirror reflecting 0.15 w/mm² total flux will deliver about the same amount of visible energy as a silver mirror reflecting 0.3 w/mm² total flux. The decrease in total flux which is thus obtained by the use of a dichroic reflector means that films will absorb less heat while the same screen brightness level is maintained.

Figure 10 presents a plot of the total energy absorbed by the high visual density film samples as a function of the visible energy incident on them. These plots readily show the reduction in energy absorption that is obtained by the use of the dichroic mirror at a given visible energy flux (screen brightness level). This plot can be visualized as an indication of the "thermal efficiency" of projection.

In ideally efficient projection, only energy that contributes to screen brightness would be allowed to heat the film.

† In this work, brightness level will be correlated with *total* visible energy. The difference in brightness sensation to the eye due to different color temperatures of the light (photopic luminosity) is not considered, since the difference in this case is minor.

Table II. Calculation of Energy Absorbed by Films in Two Reflector Systems Operating at the Same Total Incident Flux.

	Energy, w/mm² Visible	Infrared	Total
Silver Reflector Lamphouse			
Reflected on film	0.10	0.20	0.30
Absorbed: by 5382	0.10	0.05	0.15
by Technicolor	0.10	0.04	0.14
by 5302	0.10	0.20	0.30
Dichroic Reflector Lamphouse			
Reflected on film	0.20	0.10	0.30
Absorbed: by 5382	0.20	0.03	0.23
by Technicolor	0.20	0.02	0.22
by 5302	0.20	0.10	0.30

This ideal condition of zero infrared absorption is represented in Fig. 10 by a 45° (dashed) reference line. The displacement of a point on a given curve above the reference line indicates the amount of unusable infrared energy absorbed by the film at the given condition. In actual projection, with an image of varying densities, these plots indicate approximately the maximum energy absorption which may be encountered at a given brightness level.

At these conditions, the biggest reduction (approximately 50%) in energy absorption due to the use of a dichroic reflector is noticeable in the black-and-white film, but a sizable reduction (approximately 20 to 25%) also occurs in the color films. The dichroic mirror minimizes infrared reflection, and since the black-and-white film is more opaque to infrared than the color films, it derives the greater benefit from the dichroic mirror.

CONCLUSIONS

(1) This paper deals with two important areas of projection — light and heat. Good projection practice dictates a maximum of light — for a bigger, brighter screen image, with a minimum of heat — for elimination of blistering and focus difficulties and extension of useful film life. Energy in the visible range heats the film just as effectively as infrared or ultraviolet energy. However, since visible energy is the source of the light necessary for the screen image, this heat must be tolerated. Infrared energy, on the other hand, contributes only to the heating of the film. A major objective of good projection, then, is to minimize or eliminate the absorption of infrared energy by the film.

(2) Generally, color films are more transparent to infrared energy than black-and-white films. As a result, they are less susceptible to thermal difficulties like blistering and screen image quality deterioration. Also as a result, it is possible to project color films at higher intensities and with greater screen brightness than is permissible for black-and-white films.

(3) Since approximately two-thirds of the energy emitted by the high-intensity arc is in the infrared range, an infrared filtering device such as a dichroic mirror is very useful in preventing unnecessary heating of the film. When a dichroic mirror is introduced into the projection system without changing the carbon arc wattage, heating of the film will be reduced with no substantial change in the screen brightness. The reduction in infrared energy will particularly benefit the black-and-white films.

(4) In filtering out the infrared energy, the dichroic reflector causes a shift in the distribution of the reflected energy, in that there is a substantial increase in the proportion of visible energy striking the film. This change in distribution will affect the heat load carried by the color films, since the absorption of energy by color films is dependent on both the amount and the distribution of the incident energy. The high-density black-and-white films are affected only by the amount of incident radiation, regardless of distribution.

(5) The decreased reflection of infrared energy in a dichroic reflector system offers the possibility of increasing the arc wattage in a lamphouse equipped with a dichroic reflector to obtain increased screen brightness without adding to the heat load the film presently carries in a silver reflector lamphouse. If such an attempt is made, however, care must be taken (by proper calculation beforehand) not to increase the arc power excessively. A relatively high proportion of visible energy is present in the energy reflected onto the film by the dichroic mirror. At the same time, color films show their greatest energy absorption in the visible range. As a result of these factors, a rise in the arc wattage of a dichroic reflector lamphouse will cause a greater increase in the heat load on color films than would a corresponding rise in a silver reflector lamphouse.

(6) The important point, therefore, is that in projecting color films — unlike black-and-white films — it is not sufficient merely to state the visual density of the film and the total amount of incident energy. In order to define the thermal stresses imposed on color films during projection, one must also know the spectral distribution of this energy and the absorption characteristics of the film being projected. The data and calculations presented in this paper can be useful references in taking account of these considerations.

Acknowledgment: The author wishes to express his appreciation to F. J. Kolb, Jr., for his invaluable suggestions and guidance in the course of this work and to P. J. Klaus who prepared the drawings.

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1. W. W. Lozier, National Carbon Co., private communication, April 21, 1948: reaffirmed recently.
2. H. H. Schroeder, and A. F. Turner, "A commercial cold reflector," *Jour. SMPTE, 69:* 351–354, May, 1960.
3. F. J. Kolb, Jr., "Air cooling of motion-picture film for higher screen illumination," *Jour. SMPE, 53:* 635–664, Dec., 1949.

Discussion

C. E. Heppberger (*National Carbon Co., Chicago, Ill.*): Were any of these studies made using mirrors 14 in. in diameter?

Mr. Yavitz: No sir, the mirror properties that we used in calculations were all published values and are theoretically a property of the mirror material itself rather than any particular configuration of this material. The specific reflectance properties of the mirror should not change with the size or configuration of it.

While the reflectance properties of the mirror material do not change with size, it is true, of course, that the total amount of energy collected and reflected by a mirror depends on many factors of lamphouse design. This is why this paper treats energy reflection as a percentage of the energy originally collected by the mirror. This makes the paper more general in application, and does not restrict it to any single mirror size or particular lamphouse design.

CBS-KNXT Computer Control System for Program Switching

By ADRIAN B. ETTLINGER

In the new CBS-KNXT studio plant, located in Hollywood, a special-purpose digital computer designed by TRW Computers Co. is used to control the sequential switching among the various program components. Automation of the switching functions during the recurrent station-break "panic periods" allows the operator to devote his primary attention to maintenance of quality. The use of a computer has resulted in a highly flexible system with a number of convenient operating features. In addition to a detailed description of the KNXT installation, operational experience gained in this pioneer effort is reviewed.

ON DECEMBER 31, 1960, CBS-owned television station KNXT moved into new quarters on Sunset Blvd. in Hollywood, in the expanded and remodeled CBS Columbia Square building. The planning of the new facilities was carried out with a view to creating the most efficiently integrated operation possible. Early in the planning stage, it was recognized that automatic station-break switching would make a major contribution to such efficiency.

While station-break switching requires a high order of manual dexterity and sense of timing on the part of the operator, it also has an inherent capability for mechanization, since each operation is completely predetermined. The maintenance of picture and sound quality, on the other hand, particularly with short sequences of film or video tape, is a difficult problem, only partly alleviated by some of the recently introduced automatic controls. In the design of the KNXT control center, automatic switching was introduced to permit the operator's attention to be more fully concentrated on supervision of program material transmission quality.

In surveying the various types of automatic switching systems being offered to the broadcasting industry, the conclusion was reached that a new approach would be desirable to avoid certain limitations of existing technique. It was desired that the system be capable of storing at least several hours of program continuity data, yet also permit rapid changes of stored data from a central control position. Punched paper tape, the major bulk storage medium then in use, involves an awkward handling problem which is eliminated if a random access memory is used. Computer technology was, therefore, explored, and the system which evolved provided a selection of features and degree of flexibility which would have been prohibitively costly if attempted by more conventional means. The computer system was supplied by TRW Computers Co., Division of Thompson Ramo Wooldridge, Inc.

Presented on May 12, 1961, at the Society's Convention in Toronto by Adrian B. Ettlinger, CBS Television Network, 485 Madison Ave., New York 22.
(This paper was received on August 3, 1961.)

The Design Approach

The use of a digital computer for automatic program switching virtually presents the system designer with "an embarrassment of riches." In terms of storage capacity and functional capability, there are very few limitations to what can be accomplished. The major problems lie in the area of optimizing the man-machine relationship, maximizing the efficiency of usage of the available storage, and achieving high inherent reliability.

The introduction of automatic switching into the operation of the new KNXT facilities has been planned as a developmental process. In the initial phase, the number of functions to be controlled by the automatic system has been limited, and manual initiation of each station-break sequence is employed. In the interest of facilitating later expansion into whatever further areas of automatic control prove to be operationally feasible, design flexibility was considered of major importance. Indeed, the computer approach appeared to be the only method of achieving an "open-ended" type of design that would not require extensive reconstruction to accommodate certain types of expansion.

In the design of the display and control panels, the objective was to provide the operator with fully adequate information and control capability, yet in an arrangement as simple, as logical, and as least prone to error, as possible.

The equipment operated by the system consists of the following:

(a) a 21-input video switcher;
(b) ten (expandable to twelve) film projectors (requiring 3-sec. prestart);
(c) two (expandable to four) videotape recorders (requiring 7-sec. prestart);
(d) a special audio switcher, equivalent to four independent, three-input selectors;
(e) two twelve-input audio preselection switchers; and
(f) a 36-position random-access slide projector.

Time Designation

The major task of the system is to switch video and audio sources on the air at the proper time. The operator must be provided with a display which keeps him informed of the progress of a sequence. The method of time designation required a choice between two general types of approaches. One method is to designate each event by a clock time, and provide a matching digital clock readout, so that the event is switched when the two displays match. As an alternate, each event can be designated by its duration, and a count-down display can be used to display continuously the time remaining in the event on the air. It is apparent that comparison of two 6-digit displays for similarity, as required if clock time is used, would be more prone to error in an emergency situation than would observation of a direct display of remaining time. Therefore, the countdown method was chosen as the more satisfactory to permit quick recognition of the situation by the operator. Operation by clock time has been allowed for, but in a manner that subordinates the display of clock-time information to a lower priority location on the display panel.

Display Panels — Event Format

The complete computer system is packaged in two broadcast racks. Figure 1 shows the equipment prior to installation.

On the display panels, the highest priority information, the actual switching event data, is on the right side. A close-up of these panels is shown in Fig. 2. The top panel indicates what is on the air (center), and how much time remains (left) before the next switch. This establishes the format for the three remaining event panels which display similar information in a paralleling manner. The second panel is for the "next event." Here, the parallel display to the dynamic "time remaining" of the on-the-air panel is a static display of the duration of the next event. When "time remaining" counts down to zero, the next event's duration moves up to the time remaining display and immediately starts counting down. The readouts for video and audio in the on-the-air panel are actually connected to station switching equipment and reflect its state, regardless of whether manually or automatically switched. The next event video and audio displays reflect the state of memory

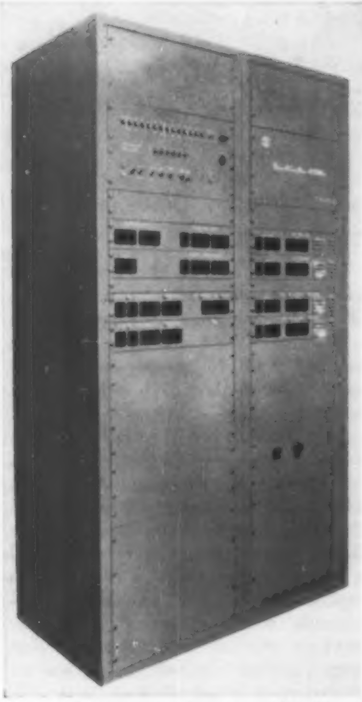

Fig. 1. The computer system. Packaged in two broadcast racks, the unit measures 44 by 24 by 87 in.

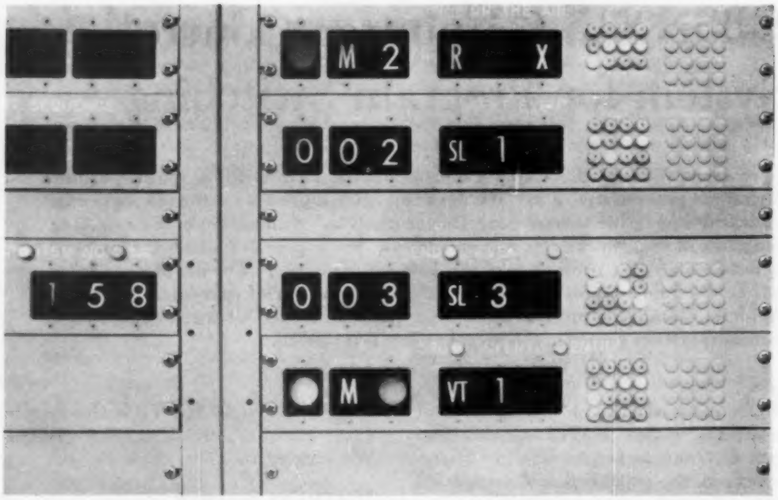

Fig. 2. Event display panel. Program sources are identified by "plain language" designations.

relays through which switching power will pass when the next automatic or manual switch is made. The nature of this circuitry is such as to ensure virtually foolproof reliability between the display and the actual switching circuit.

The lower two event displays, being of lower priority in importance, are permitted to serve a dual purpose. Their primary function is the searching out, changing, and entering of switching event data. As a secondary function, they are used operationally to display the second and third upcoming events. This function is performed when the system is in the "operate" mode. In the "search-entry" mode, the upper display shows the content of any desired switching event, while the lower display is used somewhat as a writing tablet to construct any new switching event to be entered either as a new event or replacement for an existing event. The provision of two event displays for search and entry permits a positive check, on a quick comparison basis, that an event has been properly entered.

Data Entry

The data entry and control panel is shown in Fig. 3.

The principle of operation of the keyboard can be illustrated by a description of the process by which a switching event is prepared. When the system is ready to receive event information, the operator uses the data entry keys in a similar manner to the ordinary sequentially-operated ten-key adding machine keyboard. Digits and characters are illuminated successively from left to right as the keys are operated. The numbered keys have alternate meanings for the mnemonic characters which are used in some display locations instead of numerical digits. The characters A, BK, TP, R, ST, VT, 16, SL, and 35, for example, are used to describe classes of video signals as the first character of the video source designation, and constitute the alternate meanings of keys 1 through 9, respectively. This system, when combined with the versatility of the projection-type digital display, permits the automatic switching system to use the same "language" to which the operators are accustomed in manual operations. When the entry display is filled, operation of an "enter" key causes the event to go into storage, and also to be read back out on the search display directly above. The provision of separate search and entry displays permits a quick comparison to check that the event has been properly entered.

In the action just described, a pattern of sequential key depressions has caused a corresponding pattern of display, combined with an internal storage operation. The effect produced by a given pattern of key depressions is determined completely by the computer program, which consists of magnetic digital information recorded on a memory drum. This program can be changed at will, so it is apparent that a large area of functional modification and expansion can be carried out on the system without requiring any physical change in the hardware.

Switching events are identified by an "item number." The drum storage space allotted for item storage provides a capacity of 220 items. This number was determined arbitrarily on the basis of initial operating needs and a balance in apportionment of reserve space between item information and possible future computer program expansion. The item capacity is subject to possible expansion, up to a maximum of 1400 items, should such capacity ever be required.

Switching Sequence Control

A view of the operator's control position, showing the relationship between the displays and the control panel, is shown in Fig. 4.

To control the operational sequencing of the system, the operator is provided with two primary controls, a "switch" button, and a "hold" button. When a station-break sequence is awaiting a manual start, the "time remaining" display shows the letter "M" with two red disks. Any event can have a duration of "manual," which means that, when it goes on the air, the countdown will not operate and the event will stay on the air until the "switch" button is operated. The switch button puts the next event on the air, and if it is the first of a series of duration events, as for a station-break sequence, the sequence starts counting through. The switch button can also be operated while the countdown is running, for the effect of accelerating a sequence by cutting short the present event. The hold button, when actuated during a countdown, has the effect of putting "manual" in the time-remaining display, to decelerate a sequence by holding the next event off for a manual switch. A third button is provided to "discard" conveniently the next event, when an event must be bypassed.

Prestarting of film projectors and tape machines during an operating sequence requires no attention from the operator. The computer continually scans advance events and puts out a start impulse three seconds in advance of each film projector

event and seven seconds ahead of each video-tape event. This applies regardless of whether the machine to be started is the "next event" or happens to be several events away because of a series of short events. When a video source requiring prestart is coming up on a manual start, the operator is notified by the last digit of the time remaining display which, instead of showing the usual red disk, shows a digit corresponding to the anticipated time. The switch key under these circumstances serves as a start key, and video is not switched until the countdown reaches zero.

While every effort has been made to provide all manual override controls the operator may need, it is recognized that, in the last resort, there can be no substitute for taking over manually in an emergency. When the film breaks, or the network feed fails, human judgment is usually superior to a computer's in salvaging the situation. Therefore, the operator's position includes a complete set of manual controls for operating all equipment controlled by the computer. The manual control is always connected and overrides computer control.

Modes of Operation

The system can be placed in any of three modes by the mode selector buttons on the left side of the control panel (Fig. 3). Sequencing of events, i. e., the actual timed control of station equipment associated with the upper two event panels, proceeds regardless of the mode. The "operate" mode is the normal state when the data keyboard is not being used, and transfers the lower two event displays to their alternate function of showing the second and third upcoming events. The "search-entry" mode places the computer in a program where key depressions are interpreted in the variety of patterns required to prepare and enter switching data. The basic event-entry process has already been described. There are, in addition, several convenience keys for such operations as clearing erroneous information, repeating information, and similar functions. When the search-entry mode is first entered, all associated displays are cleared. The first three key depressions are then interpreted as an item number which is displayed as punched, and when complete, the content is displayed. Two convenience features for the item selection are a "reset" button which clears all displays for entry of another item number, and an "advance" button which adds one to the item number display and shows the content of the next higher number. After display of an item, successive key depressions prepare a new item for entry, as previously described.

Special Routine Mode

The third mode is known as "special routine." This mode is a major vehicle

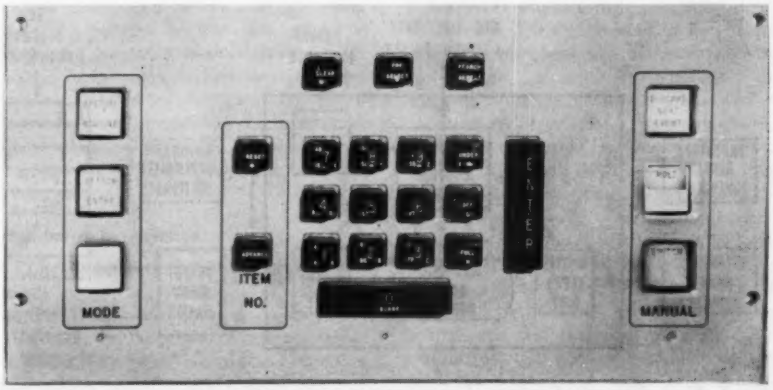

Fig. 3. Data entry and control panel. Mode selectors are on the left, and manual intervention controls on the right. The data entry key group in the center is built up around a ten-key adding machine keyboard.

for implementing the inherent flexibility of the computer approach. There are a number of possible functions of considerable utility which the computer can perform if instructed to do so. Normally, the addition of functions to any machine requires the addition of physical controls to actuate the additional functions. With a computer, however, having a keyboard such as this one has, it is necessary only to write the proper program and record it on the drum to have the machine perform any desired internal function when a particular sequence of keys is operated. Thus, the special routine mode is set up so that entry of any of several serial numbers, followed by a specific format of data, causes the computer to perform a given operation.

One of the most operationally useful routines is to place a given item number in the next event position of the operating sequence. Ideally, this operation is needed only once each day to start the day's operation, but it also has utility in getting to a group of events which may be left in the machine from day to day, such as the sign-on or sign-off procedure. Another useful routine permits erasing any block of items. Test routines are also programmed, such as a display-

Fig. 4. Overall view of the operators position. Complete manual control is provided for all computer-operated station equipment. Display panel features, on the left side, lower priority preselect and clock time information.

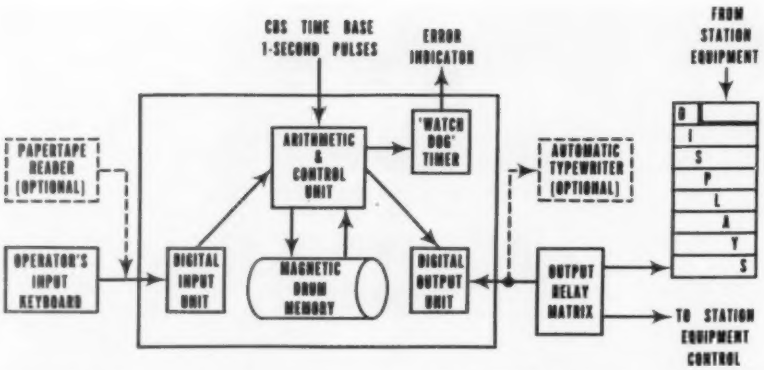

Fig. 5. Block diagram of system. The computer is the central data storage, control and communication unit between the operator and station equipment.

testing routine which illuminates any digit called for in all digital displays. Many unassigned serial numbers are reserved for later addition of whatever routines are shown to be desirable by operating experience.

A particularly interesting special routine is one that permits modifying the computer program that governs the basic system operation by direct use of the data keyboard. The use of this special routine permits an operator, merely by pushing buttons, to modify functional features of the system. As an example, if video-tape machines were improved to permit a five-second prestart time, the program modification to accommodate this could be entered from the keyboard. Likewise, any new special routines can be so entered. For safety, this feature is inhibited unless a special shorting plug is inserted on a rear panel of the equipment.

The Preselect Feature

The portion of the system as thus far described does not provide for operation of all the station equipment originally listed. A random-access slide projector and two 12-input audio preselectors are operated, but are not included in the switching event format. An alternative method of handling these functions was developed in order to enhance the efficiency of storage utilization and to provide expansion capability. These functions might have been included within the event format, but it is apparent that doing so would have required expanding the size of each of the four event display panels. In addition, the storage space allocated for each event would have had to be large enough to accommodate the additional information. Such an extension of hardware and storage space would have been inefficient, considering that the supplementary data would be used in conjunction with only a small fraction of events. Furthermore, addition of more similar functions at a later date would be extremely awkward.

A method was therefore adopted of an alternative use of an item space to be known as a "preselect." A set of displays for search and entry are provided which are used in a flexible format to designate any of a potentially large number of preselect systems. The first character identifies the station equipment that will be switched; the remaining characters define the position to which it is switched. Since none of the equipment operated in this manner performs a "hot" switch, precision of timing of preselects is not important, as long as they are actuated in proper sequence with respect to the actual switching events to which they apply. Preselects are thus inserted in sequence as required, and the system outputs the preselect impulses during the one-second interval immediately following the preceding event.

The nature of this system permits its later extension into other areas of station operation at little additional expense. Such tasks as sync-lock control selection, assignment of equipment, and output channel routing could be added without major modification to the computer system. Additional display characters are used to identify each additional function, so that no displays need be added. The output system is in binary format, using one set of twelve lines for all information and a common line for each function. Several spare common lines are available for expansion.

Another contemplated area of expansion is the tie-in of the computer switching system with any future automatic data processing system which may be adopted for traffic and billing operations. The feasibility of this type of interconnection is much enhanced by the ability of the computer to perform the interpretation and format conversion functions required for such a system.

Clock Time Operation

The preselect feature has also provided a neat solution to the problem of economically accommodating clock-time operation. As in the case of preselect switching, clock time might have been included in the event format, but again at the cost of efficiency, since when basic timing is by duration it is necessary to predetermine only the clock time of the start of each station-break sequence. Clock time is, therefore, inserted as a "preselect" type of item in the data sequence. Whenever a "clock preselect" is output in sequence, a display register is set to retain the time information. An external coincidence circuit takes this register as one input and a continuously-running digital clock as the other input, and supplies an initiating pulse to the computer. The initiating pulse is supplied one minute in advance, and starts a one-minute countdown, so that the operator is given an advance warning; and no special action is required for prestarts. The clock-time start is effective only when the "duration" of the on-air event has been established as "clock," identified by two green disks flanking a letter "C." (This is a second alternative to a true duration in a switching event, similar to "manual.") The actual introduction of clock-time initiation of station-break sequences into KNXT operations has been deferred until a study of network program timing problems can be completed.

The upper panels on the left side contain readouts which display the state of each preselect switcher. Except for "time of next sequence," which reflects a relay register internal to the computer racks, each of these displays is driven from the external station equipment that is operated by the computer.

The Computer

A block diagram of the system is shown in Fig. 5.

The computer, which was developed by TRW Computers Co., Division of Thompson Ramo Wooldridge, Inc., employs a magnetic drum memory. In size of memory and speed of operation, it is similar to the smallest of the general-purpose computers that are applied to business data processing and scientific computing activities. Because of its command structure and input-output system, however, it is categorized more accurately as a process control computer, the type which has been employed for automatic control in oil refineries, chemical plants, steel mills, electric power stations, and other industrial areas.

The memory drum has a capacity of 5,000 twenty-four bit words, expandable to 8,000 words by adding additional tracks. The drum rotational speed is 3600 rpm. The magnetic memory drum is considered a thoroughly-proven component, being the basic form of memory for the "first generation" computer designs which have been in successful operation for several years.

The memory capacity is divided between item data storage space and computer program space. In the initial arrangement, only 20% of the installed capacity is allocated for item data storage. Reserve space is available which

could be allocated in the future either for additional item capacity or for additional programs. Such further programs could be either additional special routines or an expansion of functions in the main operating program.

The circuitry in the computer is completely solid-state, and is packaged on plug-in printed circuit boards for ease of maintenance. Computer circuitry involves a large number of relatively simple elements, complexly interconnected. High overall reliability demands very high reliability of the individual elements. To this end, high-precision, high-stability components are universally employed in circuit modules whose design has been thoroughly optimized and exhaustively tested.

Since the operation of the computer circuits is completely digital, marginal circuit failures will first appear as an occasional erroneous bit. The system employs a "parity" check technique which can recognize when one bit of a word has been erroneously read from storage. Such errors are common on an infrequent basis in many digital computer installations, presumably caused by an occasional severe electrical disturbance outside the system. The program is organized so that such an error, on a transient basis, will not cause a machine malfunction, but will notify the operator by a special display pattern, in the meantime continuing with the proper action. Any unusual increase in the frequency of parity errors is an indication of a marginally-performing circuit calling for maintenance attention.

The output system of the computer consists of 84 mercury-wetted contact relays, which are operated in groups of twelve at a rate of 8 milliseconds per group. A subsidiary binary relay system, operated by a portion of the main output relays, is employed to operate displays and preselect functions at a slower rate.

There is a further relay system external to the computer system which performs a number of auxiliary functions, largely involved in the control of film projectors. This external system provides a change impulse to slide projectors at the end of each slide event. An option is available to stop projectors and video tape machines at the end of the corresponding event. A preview impulse is supplied to each film projector to show it on a still-frame basis when it becomes the next event. Circuit provisions have been made for possible addition of a future preview video switcher to display on a monitor the video signal from the next event source.

Operating Experience

The computer control system was ready for operation when the new KNXT facilities were inaugurated on Dec. 31, 1960. The initial period of operation was attended by the normal amount of difficulties encountered in shaking down any new complex electronic installation. The presence of such a radically new and different type of equipment for a broadcasting plant, however, gave rise to a somewhat new and different pattern of problems. Automatic switching was found to impose a new and unaccustomed type of burden upon the operator. A single mishap during an automatic sequence, whether the result of a control system malfunction, improper data entry, or, as is more common, controlled equipment failure, creates a sudden shock of emergency from which the operator may be very hard put to recover smoothly. In manual operation, a failure can often be recovered more quickly because the operator has the content of the sequence firmly in mind. In the early period, the scattered mishaps which occurred were often compounded by the operator's efforts to recover; the operators, however, quickly developed the appropriate reflexes to cover emergency situations. While some further debugging was necessary on various aspects of the computer system and its associated equipment, no major shutdowns were required. The debugging problems were exclusively concerned with components of the system peripheral to the computer and memory system itself. Some relatively complex relay logic was necessary to permit random-timed manual interruption of computer sequencing with full reliability; and continuous operation revealed a few design loopholes that had been undiscovered in the testing period.

General shakedown of controlled equipment was a hindering factor, since isolated, nonrepeatable switching failures were often speculatively attributed to the computer system to the unfair detriment of its reputation. In summary, it appears reasonable to state that the shakedown period of this equipment was attended with no greater difficulties than usually encountered with any new computer installation, or with any new type of equipment in a broadcasting plant. There is little doubt that many design features, particularly the capability to search out for checking purposes any sequence of events, contributed to a minimization of the error rate in the early period. The system has, since about the middle of March, 1961, been used continuously for all functions which it was originally intended.

Inasmuch as so little time has elapsed since the debugging period can be considered finished, it is difficult to estimate the ongoing reliability of the system. Any failure of the computer system itself will generally be revealed by positive evidence that can be recognized before a station-break sequence is initiated. The impression established to date is that a computer system's reliability is almost entirely contingent on its peripheral equipment — the power supplies, external relay logic, input-output equipment, etc. This suggests that the use of a computer memory and control element as the core of this system has in no way adversely affected the shakedown and reliability problem as compared with any other approach that might have been used, and indeed, may well have eased the problem because of the convenient operational features it permits.

While rigorous comparison is difficult, a survey of the station's discrepancy reports certainly appears to indicate that automatic switching achieves a reduction in the error rate over manual switching. One of the operators volunteered the statement on one occasion that he considers the computer control system as a tool that makes his job easier and permits him to do it more effectively. The aim of releasing the operator's attention to the important duty of monitoring program quality has been achieved.

Picture Characteristics of Image-Orthicon and Vidicon Camera Tubes

By R. G. NEUHAUSER

The vidicon has not generally replaced the image orthicon for live broadcast work in spite of the fact that its resolution is as good or better, and its effective sensitivity now approaches that of the image orthicon. This is primarily due to the basic difference in the picture characteristics of the vidicon and the image orthicon.

The secondary electron redistribution characteristics of the image orthicon, which are at times criticized as producing an inaccurate picture, can contribute to making the picture appear to be a somewhat better picture than the TV system is normally capable of producing, when the human eye and brain are considered as part of the system. These characteristics also compensate for some of the basic aberrations in a TV electron-optical system. Basic differences in the signal characteristics generated by the image orthicon and the vidicon are described in detail. Methods for obtaining the best performance from each are suggested.

It is highly unlikely that the vidicon as it is now known will generally replace the image orthicon as a studio broadcast TV camera tube because vidicons and image orthicons are entirely different "breeds of camera tubes." The image orthicon produces a different type of picture than the vidicon, in spite of the similarity of the normally accepted criteria for picture reproduction and fidelity of both the image orthicon and the vidicon, such as resolution, sensitivity, signal-to-noise ratio and lag characteristics.[1]

This paper discusses the difference in the nature of the picture generated by image orthicons and vidicons. The main point that is developed here is that the picture generated by the image orthicon is uniquely suited to the television system. The image orthicon produces a picture that can appear to the eye to have a higher contrast than the actual contrast of the image on the face of the television receiver, because the character of the picture complements two important characteristics of the human eye.

Image-Orthicon Black Border

Anyone with even a small amount of experience in the television industry realizes that the image orthicon is capable of producing a black border (sometimes called a black halo) around a brightly illuminated object. There has long been a running battle between purists and practical men concerning the desirability of operating image orthicons so that this black border is produced. Although purists endeavor to make a picture that is an accurate reproduction of the scene, practical men consider it expedient to open up the lens as far as possible to produce a "snappy" appearing picture without regard to accuracy of reproduction of the scene. If either of these views is carried to the extreme, of course, the final result is not the best that can be achieved.

Characteristics of the Eye

A simple test of the capabilities and reaction characteristics of the human eye illustrates the principles described here. If you look through an outside window from a reasonable distance inside a room on a bright day, the window frame and drapes are practically indiscernible to your eye, whereas the wall and other furniture in the room several feet from the window can be seen clearly. Or, if you gaze at a young lady across a table in a restaurant having subdued lighting and the candle in the middle of the table happens to be centered on her face, you can not easily discern the color of her eyes or readily make out features of the center of her face, although her hair and ears are very clear to you. These tests illustrate that the eye loses its sensitivity close to a bright object, and the bright area appears to be surrounded by a dark border.

The Eye and the Image-Orthicon Picture

The image orthicon tends to behave in a similar manner under conditions of very high contrast, although viewers are not usually disturbed because their eyes and brains have been trained to interpret this effect as a normal consequence of high contrast in a scene. Therefore, except to engineers concerned with the trajectories of electrons inside the image section of an image orthicon, or to photographers concerned with the accuracy of film reproduction, an image-orthicon picture with a moderate amount of black borders around a brightly illuminated object is satisfactory as far as entertainment or esthetic value is concerned.

The significance of this black-border effect becomes more pronounced under viewing conditions less well-controlled than the viewing conditions in the TV studio control room. The actual picture-tube contrast range on a typical home receiver is probably in the order of 10 : 1, instead of a much higher value that can be achieved under very well-controlled conditions. When a television picture has "black borders," therefore, the eye recognizes the effect as high contrast, although the actual contrast may be well below the desirable contrast of a well-ordered television system.

Image-Orthicon Enhancement of a Transition

In addition to these psychological factors, there are measurable characteristics of the image-orthicon picture which contribute to the impression of a better television picture, including the high contrast obtained at the boundary of brightly illuminated objects. When the image orthicon is operated so that the highlights are even slightly above the knee of the light-transfer characteristics, the borders are accentuated, as shown in Fig. 1(a). Besides merely accentuating borders and giving an appearance of higher contrast, this characteristic actually compensates for some of the built-in aberrations of the television electron-optical system. Figure 1(b) shows an oscillogram of the step pattern produced by the same image-orthicon tube and camera used in Fig. 1(a) when the center of the lens was fogged by a thumb print. Although a dirty thumb print on a lens is not typical of television practice, it illustrates a type of degradation of an image that can occur as a result of unclean optics and multiple reflections in the faceplates of both the camera tubes and the picture tube and between the safety glass in front of a picture tube and the tube itself. This effect has been noted by people who make television-picture recording. Their experience over the years has been that a television-picture recording from an image-orthicon picture should be made with the image orthicon exposed to a higher light level than would normally be required for direct transmission. The light scattering or halation in the recording tube, the camera lens and the film itself are then being compensated by the action of the image-orthicon tube.

The Eye and Sharp Transitions

The eye judges contrast primarily by transitions of brightness and not by the actual brightness differences of two different areas. In the logarithmic reflection charts of Fig. 2, there is a distinct difference in the brightness of the several steps of the pattern. The top step pattern

Presented on May 12, 1961, at the Society's Convention in Toronto by R. G. Neuhauser, Electron Tube Div., Radio Corp. of America, Lancaster, Pa.
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Fig. 1. Oscillograph photos of the signal developed by an image orthicon: (a, left) enhancement of boundaries between areas of different contrast; (b, right) changes in waveform caused by a dirty optical system. (Note reduction in boundary enhancement.)

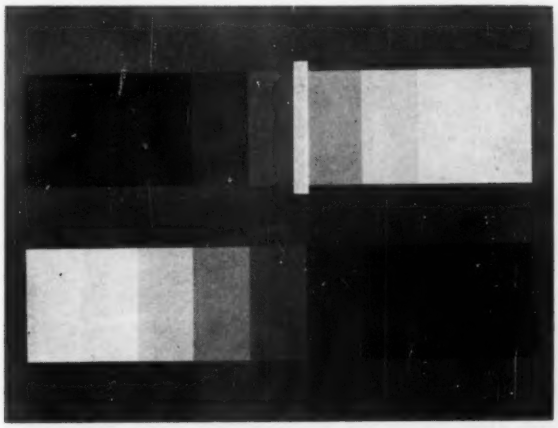

Fig. 2. Photograph of RETMA (EIA) logarithmic step chart. One transition on top step chart is blocked off by a white card, showing the importance to the eye of the transition in evaluating contrast.

of Fig. 2 shows the same step pattern with the sharp transition between two steps masked off. In this case, it is difficult for the eye to distinguish the difference in brightness values between the two steps. In other words, when the sharp transition is eliminated, the contrast range appears to be reduced as far as the eye is concerned. Therefore, enhancement or preservation of a transition or boundary apparently increases the contrast of a picture.

Additional Image-Orthicon Characteristics

There are additional features of the image orthicon which make it especially suitable as a television broadcast camera tube, particularly in studios where the action is faster than the action on film. For example, the limiting action of the knee characteristic of the image orthicon imposes an absolute limit on the amount of signal produced from extremely bright highlight glints. A disadvantage of this characteristic, however, is that very brightly illuminated highlights tend to lose most of their detail as a result of the flattening of the light-transfer characteristic when the highlights are substantially above the knee.

Another feature of the image orthicon, which has been described elsewhere, is that overexposure (operating with the highlights substantially above the knee of the light-transfer characteristic) improves its motion-capturing ability, or reduces its "lag," as it is commonly called in the terminology of the TV industry.[1] Under these conditions the apparent "shutter" speed can be substantially less than the frame rate of the television system.

An additional and very important aspect of the image orthicon is that all the effects mentioned can be minimized or almost entirely eliminated, if desired, by operating the image orthicon so that the highlights of the scene are on the substantially linear portion of the light-transfer characteristic. This operating practice is used in color television systems at the present time because distortions of light values cannot be tolerated. Such distortions vary in the different color channels and produce shifts of hue rather than simple modifications of the brightness of portions of the picture, as is the case in black-and-white television.

Vidicon Characteristics

The vidicon is able to reproduce a very accurate television picture because its light-transfer characteristic is partially complementary to the square-law characteristic of the television picture tube. Consequently, it requires little or no signal correction (gamma correction). The good resolution and recent improvements in the sensitivity and lag of the vidicon have put this tube on a par with the image orthicon as far as these characteristics are concerned. As a result, the vidicon can operate with normal TV studio lighting and produce a picture that has electrical characteristics similar to that of an image-orthicon picture. Its signal-to-noise ratio is high, and its resolution can be somewhat greater than that of the image orthicon. If the performance of image orthicons and vidicons were judged only on the basis of a test pattern, the preference would usually be for the vidicon. When a vidicon is operated with a high focus field and high focus-electrode voltage, the picture is practically beyond reproach in the normal television broadcast channel. Under these operating conditions, resolution and uniformity of focus are much improved. Signal-to-noise ratio is in the 100:1 range, and detail response is about 50% at the cutoff of the television frequency band.

However, the scene being reproduced may have a 100:1 contrast ratio. Although the vidicon can do a very good job of cramming a scene contrast range as great as 100:1 into the rather restricted contrast range of the television system, the picture viewed on the TV set appears to have only the contrast of the TV set itself. As previously pointed out, this contrast range may be very low on the normally adjusted home TV set, particularly when there is some additional light in the room. Even if the actual contrast range of the vidicon picture on the television picture tube is equal to that which an image orthicon would produce, the contrast will appear to be lower because of the lack of black border or transition enhancement effect.

Some other aspects of the vidicon performance are generally superior to that of the image orthicon. For example, the uniformity of the signal output or sensitivity over the scanned area of the vidicon is very good. In addition, the background signal is extremely flat and free of undulations.

The basic differences between the character of the vidicon picture and that of the image-orthicon picture are illustrated by the reproduction of a step function, as shown in Figs. 3 and 4. The photograph of an oscilloscope presentation of the vidicon signal waveform in Fig. 3 shows that there is a tendency for the dark level to anticipate the white step function. In addition, the small dark area in the middle has been lifted above the black level. Figure 4 shows the same vidicon signal with the light turned off. These factors tend to reduce the contrast of sharp transitions or small dark objects and to produce a picture having an appearance of lower contrast than would be expected. Rather exhaustive tests have shown that this effect is primarily due to light scattering within the photoconductor of the vidicon. It is

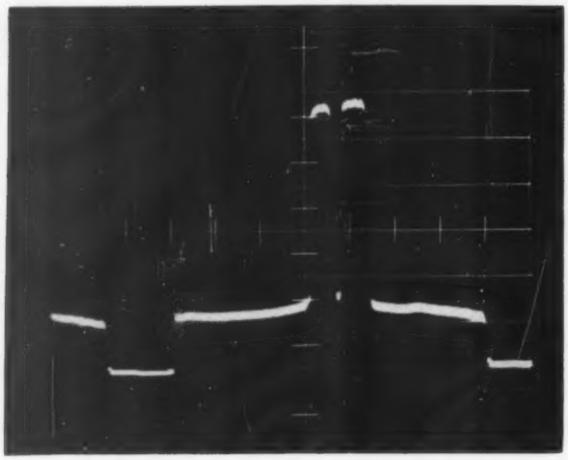

Fig. 3. Oscillograph photo of the signal developed by a vidicon, showing the loss of contrast at a transition and the reduction in contrast of small-area blacks.

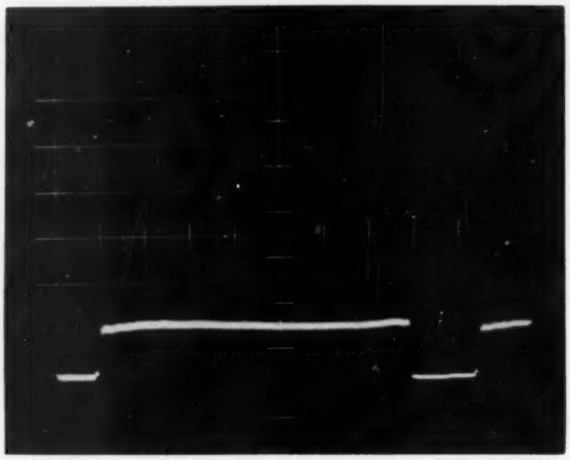

Fig. 4. Oscillograph photo of the signal developed by the vidicon of Fig. 3 with the light removed, showing extremely flat background.

interesting to note that this scattering is more pronounced in the red portions of the spectrum than in the blue and green portions of the spectrum. This difference is due, of course, to the strong absorption of blue light in the photoconductor. The variation of this characteristic with different colors of light was first noted when the vidicons were used in vidicon color cameras. In this instance the black level of the vidicon signal in the red channel seemed to rise higher than that in the blue and green channels. In addition the red channel produced lower detail contrast. This effect has been minimized in recent versions of the vidicon, although it is still present to some extent.

Unlike the image orthicon, the vidicon has no abrupt limiting action. Therefore, its ability to handle very high contrast glints or reflections is not as good as that of the image orthicon. This problem is usually handled by using sufficient beam to discharge these highlight glints and then clipping the highlight signals elsewhere in the video system. This process has its limitations because only a limited amount of beam is available from the vidicon gun.

Obtaining the Best Performance From Vidicons and Image Orthicons

When the characteristics and eccentricities of the different camera tubes are understood, it is a relatively simple matter to decide upon the proper operating conditions and precautions that must be taken to obtain the type of picture which is desired from a given camera tube.

For the image orthicon, it is probably desirable to operate with the highlights over the knee of the light-transfer characteristics to produce a slight dark halo around brightly illuminated objects. This of course can be overdone to the point where the viewer becomes distressed upon seeing a black hat floating around a blond head, or when the lapels of a business suit begin to look as if they are the black velvet on an evening dress coat. However, the use of this black halo should be carefully controlled and not be a result of careless overexposure. Overexposure may minimize adjustment of the camera on the scene, but it will not produce the best picture. For careful control of the black-border characteristic, it is imperative that the lighting be strictly controlled or that the lens iris be controlled by the camera operator. When the vidicon tube is used in broadcast pickup, the optical system must be both clean and of good quality. Otherwise there is a greater tendency for the blacks to anticipate a white transient, as shown in Figs. 1 and 3. When the vidicon is used in black-and-white film pickup, some improvement can be made by using a filter in the optical path to eliminate the red light coming from the projector. Lighting conditions for the vidicon must be controlled so that no extreme highlights are presented; otherwise the video operator will be unable to handle the picture because of insufficient beam to handle the highlights.

When both live camera scenes and film inserts are to be used on a TV production, many problems arise. A proper understanding of the characteristics and capabilities of both vidicons and image orthicons helps to offset the frustration of a technical director when he attempts to combine image-orthicon and vidicon pictures in a single production. In this instance it might be wise to close the lens of the image orthicon down to the point where the black halo is essentially eliminated. To obtain a proper balance of tonal values between the two signal sources under these conditions, it may then be necessary to add a little black stretch in the image-orthicon signal or delete some of the additional gamma correction in the vidicon amplifiers.

Both vidicons and image orthicons will probably be around for a long time because each serves a particular purpose and each has unique characteristics which make it desirable for certain types of broadcast service. In the industrial field, where accurate transmission of information is more important than the impact of the picture on the viewer, other criteria will determine the tube to be used. In television broadcast use, however, the intelligent director will make full use of the advantages offered by both vidicons and image-orthicon tubes.

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A Method of Producing Telecine Test Materials of Specified Density

By LESLIE H. HOLMES

Ten-step staircase test wedges on 2 by 2-in. slides and 16mm film have been manufactured to predetermined density values. A general account is given of a method of correlating subject reflectance with negative density, preparation of flashed paper strips to serve as a master copy and the problems associated with producing a predicted scale of densities.

IN RESPONSE to a request originating with the CBC Toronto TV Engineering Group, a method was devised to produce test materials of specified density in a reproducible manner. These test materials were to be used in setting up the standard characteristic of the vidicon telecine chain and for evaluation purposes in determining the suitability of slide and film material for television reproduction. The need and application of such test materials is completely covered in a recent paper by Murch, Wright and Ross.[1]

Slide Requirements

The initial requirement was for a 2 by 2-in. glass-mounted photographic slide which would contain two crossed staircase wedges of ten steps each having densities corresponding to those shown in Table I. Tolerances of ±0.02 for the minimum density (0.25) and ±0.05 for the maximum density were established as acceptable limits. A background density of 0.67 ± 0.05 was established as desirable, and a size relationship consistent with other requirements of the system was agreed upon. A calibration chart of the density of each step as measured with a diffuse densitometer was to be incorporated in the finished slide, thus remaining with it for future reference. The diffuse densities as measured will not of course be the same as the effective densities projected on the face of the vidicon tube. However, the increase in density due to the character of the projector system is inherent in the calculations of Murch[2] in determining the IRE scale indications of Table I.

Table I. Densities for the Calibrated Television Staircase Slide.

Test slide densities	IRE scale indications
0.25	100
0.32	90
0.40	80
0.49	70
0.60	60
0.72	50
0.87	40
1.07	30
1.35	20
1.85	10

Method of Approach

It was realized that the conventional photographic copying process was capable of achieving the desired result providing: (1) that a correlation could be established between subject reflectance and negative density and (2) that a master copy could readily be made consisting of steps of known reflectance. To ensure reproducibility, it was decided that the single-step negative process was preferable to a two-generation process and that each slide should be an original. It was also felt that the use of 4 by 5-in. sheet film in a professional view camera would initially offer many advatages over the standard miniature still camera employing film in the 35mm size. Such advantages are: single exposures may be readily made and processed as individual tests; the use of lenses having a relatively long focal length would position the image on the axis, thus ensuring maximum coverage and definition; the processing of small batches in large sheet film tanks would produce less variation in development effects than the standard reel and tank used in the 35mm still process.[3] Essentially, then, the method adopted was a simple, straightforward copying process using professional sheet film equipment to photograph a series of steps of known reflectance.

Density Correlation

Because of the presence of camera flare, it is not possible to predict density values accurately from sensitometric curves of the film emulsion to be used.[4] It is first necessary to obtain a D-log E curve that incorporates both the camera image and the flare image for the particular copying setup, i.e., scene and optical characteristics. Since the master copy was to be made of flashed photographic paper, a ten-step paper gray scale (the Kodak Reflection Gray Scale) was selected as the preliminary subject to be photographed. Test exposures were made using Ansco Versapan sheet film under carefully balanced lighting conditions to produce a minimum density of 0.25. The degree of development was varied until a gamma was found that would produce a maximum density of approximately 1.85. When the densities of the negative are plotted against the corresponding reflection densities of the gray scale that produced them, as in Fig. 1, the relationship may be studied readily. From such a combined image and flare curve, reflection densities that will produce the required film densities may be predicted quite accurately.

Preparation of Master Copy

The production of flashed photographic paper steps of specified reflectance for the original master imposes other problems. Photographic papers are supplied in a variety of surfaces which by their nature produce different reflectances — the more glossy the surface, the

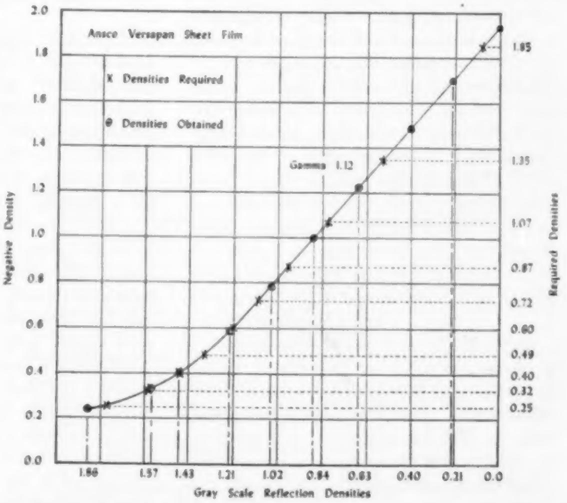

Fig. 1. Relationship of negative density to gray-scale reflection density for combined image and flare curve using preliminary setup.

Presented on May 9, 1961, at the Society's Convention in Toronto by Leslie H. Holmes, Dept. of Photographic Arts, Ryerson Inst. of Technology, 50 Gould St., Toronto, Ont.
(This paper was received on June 21, 1961.)

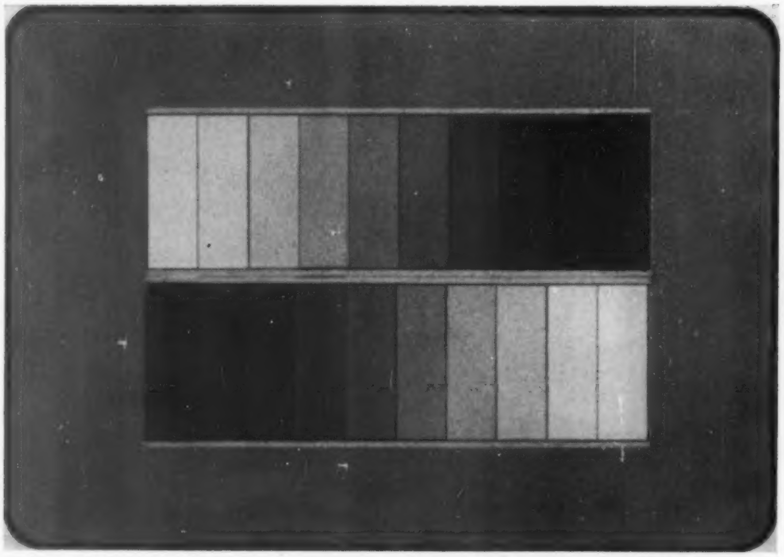

Fig. 2. Calibrated Television Staircase Test Slide as it appears in completed form.

higher the maximum reflection density available. Unfortunately, glossy surfaces also produce specular reflections of the exposing lights which can be quite difficult to control. So, a paper having a fine-grained semimatte surface — Kodak Illustrators Special, E surface — was selected as a stock for the preparation of the master copy. Because of the limited reflectance range of this surface, it was necessary to compress the total scale and increase the negative gamma slightly to obtain the desired densities in the slide.

Flashed paper densities were made by exposing the material to a very small light source at a distance of several feet, varying the exposure time in small increments from zero to several minutes. After exposure, the sheets of paper were developed out to finality in a large volume of solution. All the processing steps were carefully standardized to ensure that the results could be reproduced. In this way, required reflectances that were not obtained in the initial run could be produced quite closely in subsequent runs. After the sheets were measured and checked for density variations, small strips of appropriate value were cut up and assembled as wedges to be mounted on an 8 by 10-in. background sheet, thus forming the master copy.

Production of Slide

Exposures were made with a 4 by 5-in. camera of rigid construction (a Super D Graflex), employing the optical bench principle of alignment with the copyboard. Adjustable strip lights were used as the source of illumination. By keeping as many of the variables constant as is humanly possible, a small yield of satisfactory slides can be obtained within the stated tolerances. The use of voltage controlled light sources in fixed positions with no other ambient illumination, a fixed lens aperture, a selected emulsion batch of film and a constant timing device, all tend to increase exposure accuracy. Variations of exposure time on the order of 2.5% ($\frac{1}{2}$ sec in 20 sec) are sufficient to shift the minimum density significantly. Processing procedures must likewise be standardized to obtain consistent results. Assuming a temperature accuracy of 0.5 F, constant processing solutions, agitation every 20 sec, a 2% variation in development time (6 sec in 5 min) will cause a significant shift in the maximum density. Through experience, it was found more convenient to compensate for variations in the condition of the developing solution by making gradual increases in exposure and development time rather than adopting a replenishment system.

Figure 2 shows the finished slide, while Fig. 3 shows the final relationship of the reflection densities of the master copy to the negative densities obtained.

16mm Test Film

A 16mm version of the same test object is a necessary complement of the 2 by 2-in. slide. Using the same technique as employed previously, the problems resolved into: a selection of suitable film stock; preparation of a master copy tailored to fit the stock; standardization of exposure conditions; standardization of processing conditions; and method of measurement.

Since motion-picture camera materials generally have a gray base, it is impractical to attempt to use them to obtain a minimum density of 0.25. The clear-base stocks are designed for printing or other special purposes and as such are considerably slower, often with higher inherent contrast. After a careful survey of available materials, it was decided that Television Recording Film (Eastman,

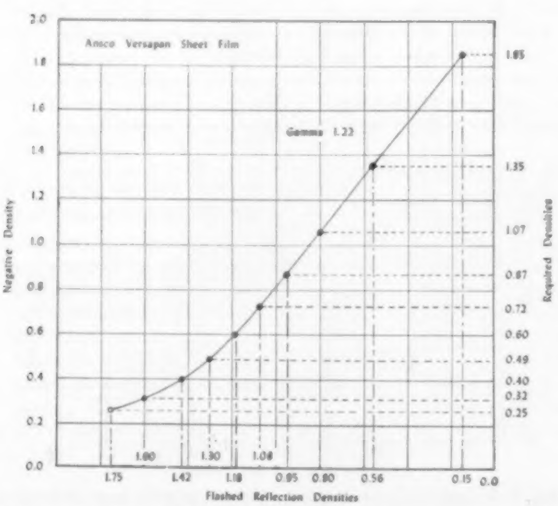

Fig. 3. The actual reflection densities of master copy used to produce finished slide, shown in relation to densities required.

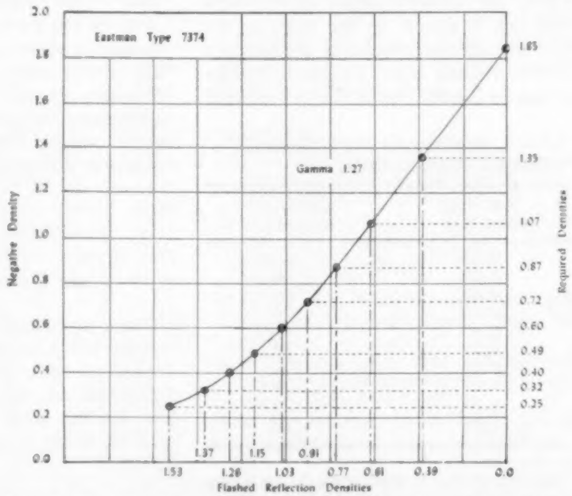

Fig. 4. Flashed reflection densities used for 16mm film (Eastman Type 7374 stock) are slightly different from those required for the slide.

Type 7374) would suit the purpose very well because of its intermediate characteristics. Unfortunately, its sensitivity is very low for camera work, but it does provide the necessary clear-base and variable-contrast characteristics; that is, it may be developed either as a negative (to a low gamma) or positive (to a high gamma).

Larger patches of the same reflection density as the master copy for the 2 by 2-in. slide were first photographed as single frames to enable accurate measurements to be made and to establish the reflection densities required for this new stock. D-log E curves were then plotted and reflectance requirements for a new master copy ascertained. When large patches of the proper reflectance were obtained and checked out, the master copy was prepared in the same way as previously described. Figure 4 shows the new set of reflection densities required for this stock.

A regular animation camera setup was used to make the exposures, but a much higher level of lighting was required in order to shoot at 24 frames/sec. Two 1000-w spotlights (under voltage control) provided the illumination, enabling an aperture of approximately $f/1.65$ to be used. The equivalent exposure index for the film under these conditions would be 1.2. For a closer exposure control, the aperture was calibrated in four arbitrary divisions between $f/1.4$ and $f/2.0$.

Processing to a gamma of 1.27 by the Constant Density Film Process as previously described by Ross[5] was essential to the success of the operation.

Because the actual wedge steps were too small for accurate measurements with ordinary densitometers, large patches of the same reflectance as the steps were photographed on head and tail of each reel for evaluation purposes. Subsequent measurements of test film steps on a microdensitometer have shown a satisfactory correlation between the density values of the large patches and the smaller steps.

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Author's Note: Since the presentation of this paper, a revised slide has been produced with densities 0.05 higher than those shown in Table I. This change has been made in accordance with the new CBS Engineering Standard, Ref. 4.2.5–3 and follows the recommendations proposed by other standardizing committees. In operation, as before, the gain and black level controls of the telecine chain are adjusted to place the minimum density (0.30) at 100 IRE scale units and the maximum density (1.90) to 10 IRE scale units.

Fiber Optics in Motion-Picture Printing

By ARTHUR J. MILLER and ROBERT HARTSHORNE

There are several uses of "light pipes" made of fiber optics in the motion-picture laboratory. Illuminating systems for motion-picture printers based on the use of fiber optics have been found to have many advantages. Several other applications of fiber optics in both color and black-and-white printing are noted.

A PAPER GIVEN at the Society's Convention in Los Angeles in May 1960 and published in the *Journal** described two types of fiber optic bundles. One, which might be described as a "coherent" bundle, is composed of fibers systematically arranged at each end in a uniform pattern so that an image can be transmitted through the bundle, either as a complete image or in a predetermined scrambled manner. The other type, which may be described as an "incoherent" bundle, is composed of fibers which are mixed and which have no definite relationship to one another at the ends or throughout the bundle. This type is used primarily for the transmission of light without image formation. In both types, the fibers are generally cemented in a sleeve at each end and left loose throughout the greater part of their length, to permit flexibility without breaking.

While there are certain uses for the "coherent"-type bundle in the motion-picture laboratory, the authors are primarily concerned with the use of an "incoherent" bundle for the transmission of light. In the past, Lucite rods or blocks have been used to carry light to the aperture of printers and viewers with varying degrees of success.

A bundle of glass fibers, each of very small diameter (approximately 0.004 in.), offers a much more effective means of transmitting light and also has the added benefit of flexibility. Each fiber consists of a core glass and a coating of another type of glass which has a lower index of refraction than the core. This coating, which prevents loss of light, effects high efficiency of light transmission from one end of the fiber to the other. If a ray of light enters the end of any fiber at too steep an angle, it may still escape through the low refractive coating. With the type of glass now being used by the authors the maximum permissible angle of entry is 34° from the fiber face or a total cone angle of 68°. In practice, we keep the entrance angle of the cone of light no greater than 60°.

One characteristic of these fibers is that the included angle of the cone of light emerging from them, while not sharply defined, is approximately equal to the entrance angle within the limits of the particular core and coating glass used.

The efficiency of a fiber optic "light pipe" is very high when properly used. We have used bundles three feet long, which have transmitted approximately 50% of the light falling on them within a 60° angle. Changing the length of the bundle affects the total transmission only slightly within reasonable limits because a large part of the total loss is due to end losses and spaces between the fibers and not to loss by absorption within the fibers themselves.

It has been found that there is ultraviolet absorption in the glass up to a wavelength of about 430 mμ. There is also a slight reduction in the transmission of deep red from around 680 mμ and extending into the infrared. Since an ultraviolet absorbing filter is normally used in color printing and the light above 680 mμ and in the infrared has no real significance, this absorption is not important.

Presented on May 11, 1961, at the Society's Convention in Toronto by Arthur J. Miller (who read the paper) and Robert Hartshorne, Du Art Film Laboratory, Inc., Tri Art Color Corp., 245 W. 55 St., New York 19.
(This paper was received on July 24, 1961.)

* L. J. Krolak, W. P. Siegmund and R. G. Neuhauser, "Fiber optics — a new tool in electronics," *Jour. SMPTE, 69:* 705–710, Oct. 1960.

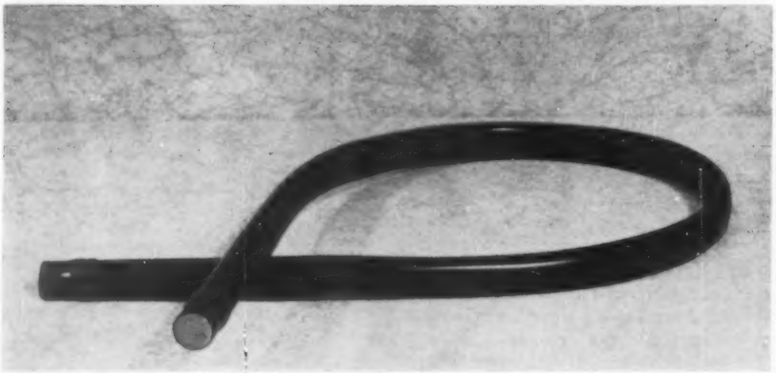

Fig. 1. Fiber optics round bundle ½ in. in diameter used for 16mm continuous printer.

Light-Transmitting Properties

One use for which fiber optic light pipes are ideally suited is that of carrying light to the aperture of a motion-picture printer. We have used two sizes of bundles for this purpose to date. One advantage is that the output end of the bundle can be shaped and sized to fit the printing aperture. This basically determines the number of fibers required in the bundle. The input end of the fibers can then be bound in a circular arrangement which permits the use of standard-type condenser lenses to fill the bundle with light.

The output end of the bundle, in addition to being shaped to fit the aperture, is also curved and shaped to pass under the center shaft of the main printing sprocket. This end of the bundle is mounted rigidly in the proper position by attaching it to the inside of the stationary aperture ring. The input end of the bundle is mounted in a fixed position with relation to a relay condenser which focuses the light from the lamphouse into the bundle at an angle of approximately 60°. It was found that for a 16mm continuous printer of a similar type it was not absolutely necessary to shape the output end; a ½-in. round bundle (Fig. 1) was used. While this proved quite satisfactory, there was still a possibility that a bundle shaped to fit the aperture might be even better and such a bundle is now being prepared. Both of these units have been used with additive lamphouses of the Fish-Schurman type to print color film (Fig. 2).

It is necessary, since the bundle cannot be broken in the middle, to introduce exposure-control means between the light source and the input end of the light pipe. Various types of automatic shutter controls or light-valve systems are available for this purpose when introduced in the proper place in the light beam.

Since each fiber carries a portion of the light to the printing aperture it is important that the entire input end of the bundle be covered by the light beam. If it is not, those fibers which receive no light will appear black when observed from the output end. Also, since there is no leakage or transfer of light from one fiber to another, any broken fibers will appear as black specks in the output end. Since each fiber is so small, this seems to have no effect on printing unless breakage of more than 15 or 20% of the fibers occurs. We have found it advisable to use a heat-absorbing or heat-reflecting glass between the input end of the fiber optics and the lamp and also to blow a small amount of clean air across the input end of the fibers. While the glass itself is not affected by heat, under extreme conditions it is possible to melt or discolor the cement which holds the fibers together.

Since all of the light falling on the input end is utilized in the aperture except for the end losses, the efficiency of such a system is very high. For example, in three lamp additive lamphouses in place of three 750-w lamps we were able to substitute three 300-w, 120-v lamps and operate them at 90 to 100 v each for long lamp life.

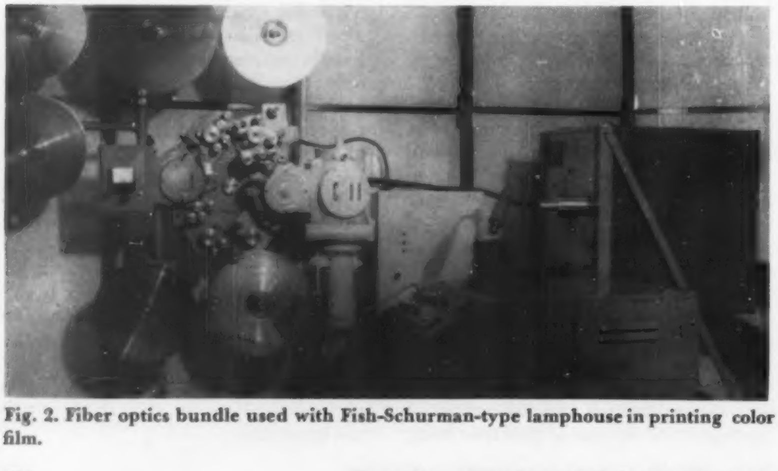

Fig. 2. Fiber optics bundle used with Fish-Schurman-type lamphouse in printing color film.

Light Pipes for Black-and-White Printing

Fiber optic light pipes can also be adapted for use with other types of light sources and can be used with equal efficiency for black-and-white film printing. In fact, while we have shown an adaptation to one particular type of printer and lamphouse, almost any type of printer can be adapted to use this method, with varying degrees of alteration, or the use of fiber optics can be incorporated in the design of a new type of printer.

When using a fiber optic bundle with a step-type optical printer it is necessary to keep the face of the bundle sufficiently out of the focal plane so that the lens does not image the honeycomb pattern of the face of the bundle.

Several other uses have been suggested for these fiber optic bundles. For example, in printing or scanning a soundtrack, it would be possible to use a small line of fibers gathered at the opposite end in a round pattern in order to pick up efficiently the necessary light. Another possible use would be to pick up coded information placed on the edge of the film to control various printer functions such as light changes, fade shutters and so forth. The flexibility and versatility of fiber optics suggests ways of solving problems arising from lack of accessibility and means of control of the light beam.

One advantage of connecting the lamphouse and the printing mechanism through a flexible light pipe is the ability to isolate the lamp from any vibration produced by the printing machine. Also, for cooling and space considerations it can be mounted behind or at the side of the printer, or even on a nearby wall.

This type of illumination has several optical advantages over the conventional condenser-type illuminating systems. Since the fibers are completely mixed in the bundle, the uniformity of field of illumination is excellent, as fibers from the various areas at the input end are distributed over the entire area at the output end, eliminating center hot spot and edge fall-off.

Control of Printing Light

Another feature of this system is the ability to control the diffusion of the printing light. The angle of the light cone emerging from each fiber approximates the angle at which it entered. By controlling this angle through the selection of relay condensers, the light can be made to enter at a relatively small angle and by placing the output end very close to the film practically specular light can be obtained. By increasing the angle of entry to approximately 60° and increasing slightly the distance between the output end and the film, diffuse light can be obtained for printing, and by variation of these conditions some control of the diffusion effect can be exercised.

This control has proven extremely valuable when printing from negatives which have been worn or handled excessively. By the use of diffused light, minor negative blemishes and scratches, particularly on the support side, are minimized in the print. It is interesting to note that while ordinary methods of obtaining diffuse light result in considerable loss or wastage of light, this method actually results in a slight increase in total light output.

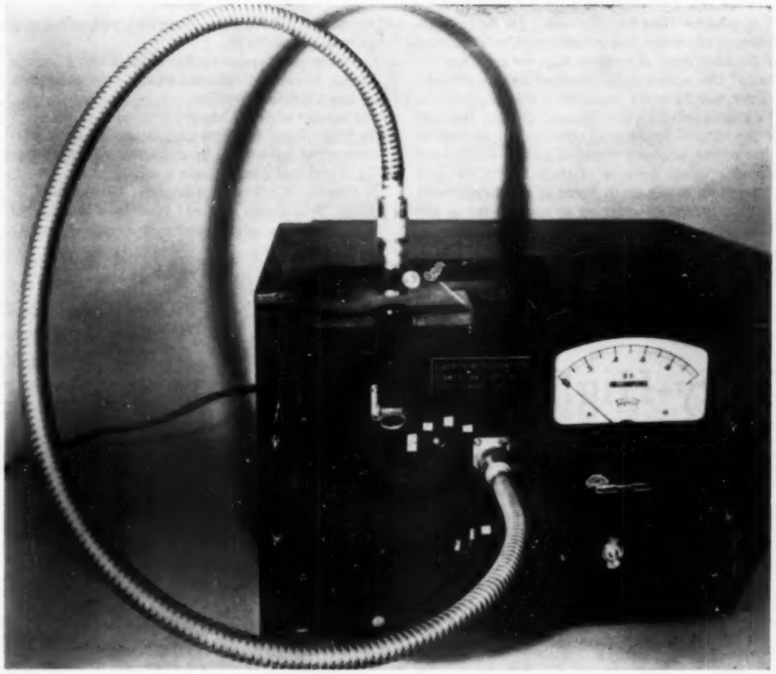

Fig. 3. Prototype of photometer with fiber probe, developed by American Optical Co.

Another use for a fiber optic light pipe is illustrated in Fig. 3 which shows a flexible small probe attached to a photometer which can be used to measure light at printer apertures. While the probe shown is not as small as can be made, it is quite feasible to make a probe having a diameter of $\frac{1}{8}$ in. which would enable measurements to be made in small printer apertures and also to check the uniformity of field in contact and optical printers and other types of equipment.

It is possible to add additional fibers to the bundle in excess of the number necessary to fill the printing aperture. These extra fibers, thoroughly mixed at the input end with the fibers used for printing, can be split out of the bundle and used for other purposes. For example, a percentage, such as 15% extra fibers, could be carried to the outside of the printer and used in connection with a photometer to monitor the amount of light being used in printing and to indicate any malfunctioning of the lamp or other light-control equipment. Another group could be taken off the main bundle and used as another point, for example, for edge printing key numbers or for a viewing light. Of course, these added fibers would be in excess of the number required to fill the printing aperture and would, therefore, increase the diameter of the input end.

It has been suggested by others sometime in the past that a reduction in the appearance of scratches, when printing from damaged negatives, could be obtained through the introduction of beams of light at very steep angles close to the edges of the negative in addition to the specular light used for the exposure. It is obvious that splitting extra fibers from the main printing bundle and carrying this light to the edges of the negative and aiming it across the negative furnishes an easy method of accomplishing this procedure.

It has long been recognized that when printing or viewing images the contrast of the printed or viewed image is frequently altered depending on the specularity or diffusion of the printing or viewing light. The degree of this contrast change is in some degree dependent on the amount of diffusion inherent in the image-forming material. Therefore it follows that, in images which are susceptible to this type of contrast control, it is also possible to control, within certain limits, the contrast of these images by the use of light transmitted through fiber optics.

Acknowledgment: The authors wish to express their appreciation of the assistance given by Dr. Walter Siegmund of the American Optical Co. in the preparation of this paper.

Discussion

George Lewin (Army Pictorial Center, Long Island City, N.Y.): It seems to me that this would be a simple way of making multiple prints from a single negative in one pass. Have you tried any operation like that?

Mr. Miller: This is a possibility if you were to use the coherent-type bundle in which the fibers will transmit an image. With a thoroughly mixed bundle such as we are using for the transmission of light, it would not be possible. The incoherent fiber bundles which we have used have the advantage of thoroughly mixing the beam of light so that any unevenness at the input end is so distributed at the output end as to produce uniform illumination over the aperture. It might be possible to place coherent bundles to carry several images for a multiple-head printer but I believe such bundles would be very expensive.

Glenn E. Matthews (Eastman Kodak Co., Rochester, N.Y.): Have you noted, in your measurements, any fallout in the light transmission with length of the tube of the fiber bundle — beyond the amount that you mentioned?

Mr. Miller: Only in a limited degree. We haven't checked very long lengths. I understand from Dr. Siegmund that these bundles can be made in lengths as long as 20 to 25 ft. The difference in transmission loss between a bundle 3 ft long and one 5 ft long is only about 4%. In other words, a 3-ft bundle would transmit 52% of the total light and a 5-ft bundle would transmit 48% of the light. The chief losses are the losses due to reflection at the ends of the fibers and to the loss of that light which falls on the cement between the fibers, rather than within the length of the fibers.

I. B. M. Lomas (Vidilon Corp., Ottawa, Ont.): Can you please elaborate a little on the use of this principle in eliminating scratches by bringing light to the edge of the film?

Mr. Miller: We haven't actually done any work with this method at this time. Others have demonstrated the reduction in the effect caused by negative scratches by introducing a small percentage of the total light used across the negative from both edges. I mentioned it in connection with fiber optics as being a simple means of getting light to the edges as compared with the methods of using lenses and prisms.

Daan Zwick (Eastman Kodak Co., Rochester, N.Y.): This extra light to eliminate scratches would not be an advantage over this diffuse condition that Mr. Miller mentioned, it is a way of eliminating scratches when you have a specular source — and I think the diffuse system that Mr. Miller described would be preferable because it would eliminate scratches of all different angles.

Have you considered eliminating the need for a mirror on the back side of the lamp by bringing light around and combining it with the normal front side, by means of fiber optics?

Mr. Miller: The lamphouse we are using has a reflector of rather low efficiency. The efficiency of the fiber optic is so great that we have not required the added light supplied by an efficient mirror nor have we required a mirror to fill in the spaces between the filament images. Because of the natural uniformity obtained by the use of fiber optics we have changed to the monoplane filament lamps because of their longer life and larger area of filament. Some of the lamps with built-in reflectors generate so much heat at the focal point that we burned the cement between the fibers and for this reason this type of lamp is generally unsuitable.

In answer to your first discussion about using the ability to control diffusion as against the method of using side illumination, it is possible you might, for reasons of definition or other reasons discussed in your paper this morning, want to use a percentage of specular light and a percentage of side light and you could obtain a mix by this method.

Charles W. Wyckoff (Edgerton, Germeshausen & Grier, Inc., Boston, Mass.): Have you considered the possibility of a tricolor printer, with fiber optics. Have you worked along this line at all?

Mr. Miller: The printer which I showed in the illustration had a three-lamp Fish-Schurman lamphouse on the printer used for color printing. It was an additive printer.

Mr. Wyckoff: So you actually control the exposure then of each light beam, is this right?

Mr. Miller: Yes, in the lamphouse and before the light enters the fiber optic.

Mr. Wyckoff: This is where you introduce the correction?

Mr. Miller: Yes.

Very-High-Gain Image-Intensifier Systems and the Photography of Single Photons With Microsecond Time Resolution

By MARTIN L. PERL and LAWRENCE W. JONES

A system consisting of image-intensifier tubes in cascade has been used to record photographically the very faint images of high-energy particle tracks in scintillating crystals. This system, currently in use on experiments in high-energy particle physics, is sufficiently sensitive to record single photoelectrons from the first cathode of the system, and capable of a time resolution of a few microseconds. A short time storage allows an electronic gate to be controlled by the event of interest, so that of 10^6 events/sec occurring, only that one event of particular interest may be recorded. The image-tube system is described together with a summary of relevant properties of available image tubes and lenses. The limitations due to noise and resolution and the improvements to be anticipated from image tubes are discussed.

High-speed photography has been employed in high-energy nuclear physics through its particular application to the luminescent chamber. As a result of this device, techniques have been evolved to record the faintest images with a time resolution of a few microseconds. Below we will discuss the need for and principle of the luminescent chamber, the properties of image tubes and other components of such systems and their operational characteristics.

In the study of high-energy interactions between elementary particles, two experimental approaches have been in common use. Bubble chambers are used to enable photography of the tracks of ionizing particles with a resolution of about 100 microns; however, each chamber photograph includes all particle tracks through the chamber, offering no possibility of preselection and giving poor time resolution.

Scintillation counters, on the other hand, are capable of a time resolution approaching 10^{-9} sec, and the use of appropriate coincidence circuits allows selection and recording of particular, rare events. However, the gross physical size of counters and the fact that a separate electronic channel must be used for each counter limit the spatial resolution to about 1 cm at best, or about 100 counter channels in the more ambitious experiments.

The luminescent chamber is an attempt to realize some of the advantages of both methods. By photographing tracks of particles in scintillators it is possible to achieve a time resolution of a few microseconds and selective recording of only those tracks or events of interest, while at the same time achieving a spatial resolution approaching 1 mm.[1]

The principal difficulty in perfecting the luminescent chamber lay in the very low light levels involved. In typical cases, a particle passing through the scintillator results in only about 1000 quanta falling on the image-tube cathode. However, this light is released in the sintillator in 10^{-9} to 5×10^{-7} sec, so that no signal is lost by shortening the time resolution to a microsecond. In order to make significant measurements on such tracks, 10 to 100 of these 1000 quanta must be recorded; therefore greater than 1% of the quanta falling on the image surface must be intensified in an image-preserving way.

Direct photography would provide neither the time resolution nor the sensitivity required in this application. The solution has been to use image-intensifier tubes to amplify the image to a level where it can be photographically recorded (a total gain of 10^5) and, by gating these tubes, to achieve the desired time resolution.

I. Image Tubes and the Luminescent Chamber System

A. Image Tubes

An image tube is basically a photocathode, simple electron optics and a phosphor anode in an evacuated glass envelope (Fig. 1).[2] Quanta of an image formed on the cathode release photoelectrons with an efficiency ϵ, where ϵ is typically about 10%. These electrons are

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accelerated through an electrostatic potential of 10 to 35 kv (depending on the tube type) before striking the anode. Electron optics, consisting typically of annular metal electrodes, focus the electrons so that electrons from each point on the cathode are focused to a corresponding anode point. The phosphor converts electron energy to visible light (e.g., for a P11 phosphor peaked at 4400 A) with an efficiency of about 10% for the most efficient phosphors. Since each light quantum has an energy of 2 to 3 electron volts, an image gain per stage of 30 to 100 is realized in such tubes.

Magnetic focusing is used in some image tubes and gives promise of yielding tubes of better overall resolution than the electrostatic tubes; however, it has so far been easier to achieve high gain with the electrostatically focused tubes. Tubes with more than one stage can be built by depositing a phosphor and a photocathode on opposite sides of a thin film of glass or mica, so that two or three stages of intensification may be included in one vacuum envelope. In the case of electrostatically focused tubes this involves compromises in the electron optics, so that off-axis resolution is sacrificed in such tubes. However, by scaling up the dimensions of the tube, the resolution at the edge of a three-stage tube may be no worse than two-thirds of the center resolution.

Multistage magnetically focused tubes have also been built using the principle of transmission secondary emission.[7] In such tubes, an electron of 4-kv energy striking a thin foil (about 300 A of aluminum backed by a comparable thickness of potassium chloride) causes the release of about 5 secondary electrons of low energy from the opposite side of the foil. By using five stages of transmission secondary emission between the photocathode and phosphor, tubes with gains of up to 40,000 have been made by Wilcock[8] in England.

A summary of the relevant parameters of the more interesting available image tubes as well as some still under development is given in Table I. Many single-stage tubes are not included in this summary, on the supposition that the chief interest is in systems with a maximum gain. The one-stage Westinghouse tubes are included since their large cathode diameter makes them particularly useful. These tubes are outgrowths of the Fluorex x-ray image intensifiers. Similar x-ray intensifiers with cathode diameters ranging from 5 to 11 in. are made by Philips (Eindhoven), Rauland (USA), C.F.T.H. (France), Carl Zeiss (Jena) and others; however, of these only the Westinghouse tube is available in a light amplifier version. Westinghouse and Radio Corp. of America are currently developing light

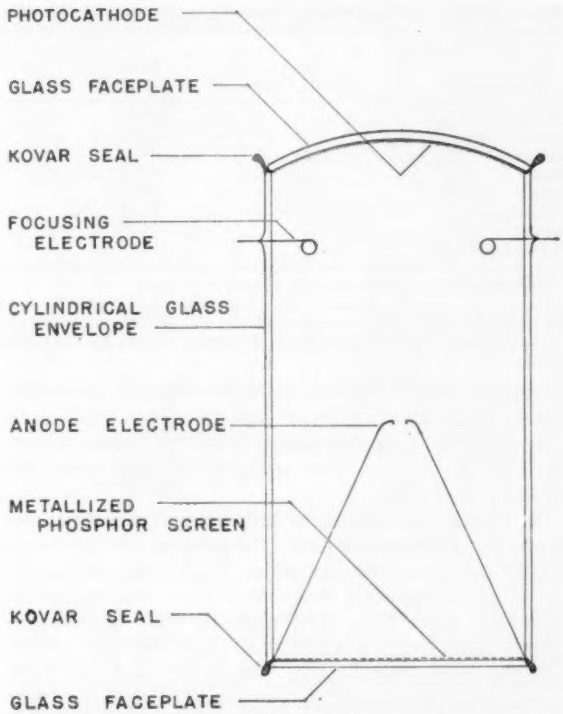

Fig. 1. Schematic cross section of single-stage electrostatically focused image tube.

Table I. Image-Tube Parameters.

Tube mfg.	Tube type	Focus	Cath. diam., in.	Anode diam., in.	Axial anode resol.[a]	No. of stages	Total volt., kv	Quantum gain[b]	Phos. type	Noise[c]	Cathode efficiency, at 4400 A, %	Cath. type	Approx. price, dollars
West.	WL7257	E.S.	5	1	15	1	25–35	10–20 80–120	P15 P11	10^7–10^8 10^8–10^9	8	S11	3,000
West.	WX4171	E.S.	5	1	15	1	25–35	20–40	P15	—	15	S20	5,000
RCA	C73458	E.S.	1	1	18[d]	2	20–25	300–2000	P11, P20	10^7–10^8	15–20	S20	3,000–5,000
RCA	C73459	E.S.	1 or 2[e]	1	—	2	20–30	~1000	P11, P20	—	—	S20	6,000
RCA	C73491	E.S.	1	1	12	3	30–45	5,000–50,000[h]	P11, P20	10^8–10^9	15–20	S20	10,000
RCA	C7294, etc.[f]	E.M.	1.5, 3	1.5, 3	15	2 or 3	20–30	1,000	P11, P20	—	—	S20	—
IT&T.	FW113[f]	E.M.	1.5	1.5	15	2	—		P11, P20	—	—	S11	—
West.	WX4342	E.M.	1	1	10–12	4[g]	25–36	>5,000	P11	—	5–7	S11	—
20th Cent.	Wilcock[8]	E.M.	0.8	0.8	15	5[g]	40	20,000–100,000[h]	P11	—	—	S11	2000

[a] Resolution in line pairs per millimeter.
[b] Quantum gain defined as light power out divided by light power in.
[c] Noise in units of quanta per second from anode with no cathode illumination.
[d] Resolution and distortion very poor at edge of field.
[e] Available with 1- or 2-in. first cathode, P11 or P15 first phosphor.
[f] Developmental types.
[g] Transmission secondary electron emission dynodes.
[h] With the best tubes of these types, single photoelectrons from the first cathode may be visually observed using a 10× eyepiece.

Table II. Typical Properties of Lens Systems: Each system consists of a pair of identical units combined for unity magnification.

Manufacturer	Focal length, mm.[a]	Rated aperture[a]	Theoretical collection efficiency[b]	Transmission[c]		60% Vignetting radius, mm.[d]
				P11	P20	
Farrand	76	$f/0.87$	0.26	0.50	—	10
Taylor-Taylor-Hobson	50	$f/0.80$	0.28	—	—	5.5
Canon	50	$f/1.2$	0.16	0.61	0.73	8
Zeiss	75	$f/1.5$	0.10	—	—	8.5
Nikkor	85	$f/1.5$	0.10	—	—	10
Carl Meyer	60	$f/1.6$	0.09	0.47	0.72	7.2
Bausch & Lomb	127	$f/1.9$	0.07	0.45	0.67	25
Kodak (Aeroektar)	178	$f/2.5$	0.04	0.28	0.38	25

[a] Focal length and aperture for each element of the pair.
[b] Theoretical collection efficiency from a Lambertian surface given by $\sin^2\theta$ where θ is the half-angle subtended by the lens: $\tan\theta = 1/2\,(f \text{ number})$.
[c] Transmission is ratio of actual transmission of the lens to the theoretical transmission, recorded for light from P11 and P20 phosphors.
[d] The recorded values are the radii in millimeters at which the transmission falls to 60% of its value on axis.

amplifiers with 9- to 10-in. diameter cathodes. In smaller tubes, resolutions up to 40 line pairs/mm have been achieved by using evaporated phosphors, but to date such resolution has been available only at a sacrifice in gain.

The background noise, or dark current, in image tubes limits the voltage, and hence the gain, at which a given image tube may be operated. This noise, causing a constant background brightness from the phosphor, probably arises from field emission by electrode elements and from positive ion bombardment of the cathode from residual gas. Within the past two years image-tube technology has progressed so that the background brightness of a good image-tube anode is almost invisible to the unaided, dark-adapted eye. The noise levels of image tubes usually rise exponentially above some voltage, and vary by orders of magnitude from tube to tube. In a cascaded system of image tubes, the noise and the cathode efficiency of each tube, rather than the gain, determine its sequence in the system.

B. Lenses

Between the film and the last image tube, between successive image tubes and (in our application) between the first image tube and the scintillating crystal, light is coupled by conventional refractive lenses. Between tubes and from the last tube to film, we have used lens combinations with unity magnification covering approximately a 1-in. field. Since in general the resolution of the system is limited by the image tubes, the lens properties of greatest concern are aperture, transmission and vignetting. In Table II several lens systems are tabulated with their transmission and vignetting; each system consists of a pair of identical units, back-to-back.

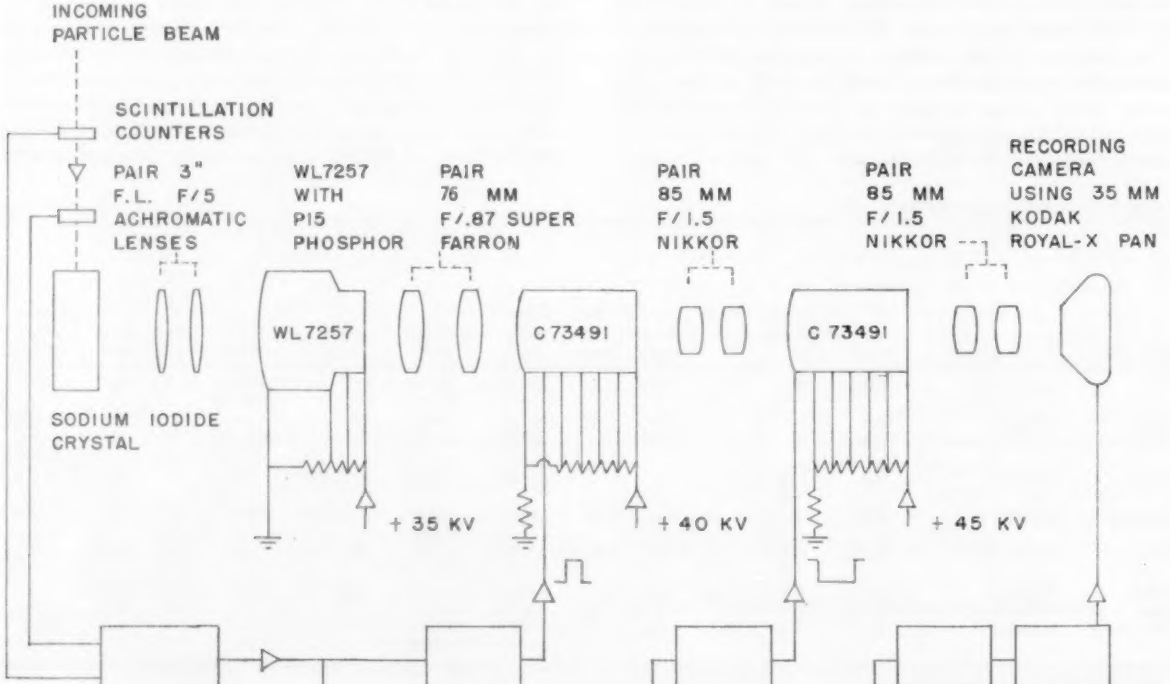

Fig. 2. Schematic of scintillation-chamber and image-tube system employing three image tubes: a Westinghouse WL7257 and two RCA C73491.

For coupling of the light from the scintillator to the first image tube, simpler lenses of longer focal length are frequently used. We have used a pair of 15-in. focal length $f/5$ cemented achromats for unity magnification and one such achromat together with an $f/1.9$, 5-in. focal length Bausch & Lomb projection television lens for demagnified images. A third system we will employ uses a Kodak Aeroektar ($f/2.5$, 12-in. focal length) together with an $f/5$, 24-in. focal length achromat; this system will give a 2 : 1 demagnified image on the 5-in. cathode with small vignetting and adequate resolution.

C. Luminescent Chamber Systems

Tracks of nuclear particles have been photographed by a number of groups using systems of image tubes. The earliest work was reported by Zavoiskii.[3] Subsequently the authors, at The University of Michigan, photographed tracks in sodium iodide.[4] Reynolds and coworkers at Princeton University, Lande and Mann at the University of Pennsylvania, and Caldwell, Hill and Schluter, and Bridge at the Massachusetts Institute of Technology photographed tracks in plastic scintillator filaments.[5] Tracks have since been recorded by groups at the Space Technology Laboratories and the Westinghouse Research Laboratories.[6]

The image-tube system we have employed most recently (Fig. 2) consists of a Westinghouse WL7257 or WX4171 with P15 phosphor; a Super-Farron lens pair; an RCA C73491; a Nikkor $f/1.5$, 85-mm focal length lens pair; a second RCA C73491; a second Nikkor lens pair; and a 35mm Kodak Royal-X Pan film (or alternatively Agfa Isopan Record). The overall resolution corresponds to dots just over 0.1 mm in diameter on the film near the central part of the field. The useful image field diameter is about 14 mm, so that a total of about $(140)^2$ resolved image elements can be obtained. We believe the system is sufficiently sensitive to record each single photoelectron from the 7 to 15% efficient photocathode of the WL7257. Since the P15 phosphor is less efficient than P11, the Super-Farrons are necessary to ensure that each photoelectron in the first tube results in at least one photoelectron in the first stage of the second tube. This phosphor is used to achieve the 2- to 10-μsec time resolution required, although it is only 10 to 30% as efficient as the P11 or P20 phosphors.

Earlier systems employed three RCA C73458 tubes following the WL7257; here the useful field of view was less and the resolution poorer; however, particle track photographs of reasonable quality were obtained. Various other intermediate combinations of tubes and lenses have also been used successfully.

The imaging of the scintillator on the cathode of the WL7257 is a compromise between track resolution (depth of field) and information gathered. The relevant properties of the scintillator and lens system are summarized in Fig. 5. The optics we have most frequently employed used an $f/5$ aperture viewing the crystal, which, including the index of refraction of sodium iodide, subtends about 1/1300 of the total light from a track in the scintillator. Stereoscopic images of tracks in a 2 by 2 by 4-in. crystal of sodium iodide have been obtained using mirrors and two lens systems to present the two images side by side on the 5-in. cathode (Fig. 3). Alternatively, a larger array of scintillator (e.g., 4 by 6 in. by 2 in. deep) has been viewed by one lens system (Fig. 4). In the future we hope to present two stereoscopic views of a 4 by 4 by 8-in. scintillator side by side on the 5-in. cathode.

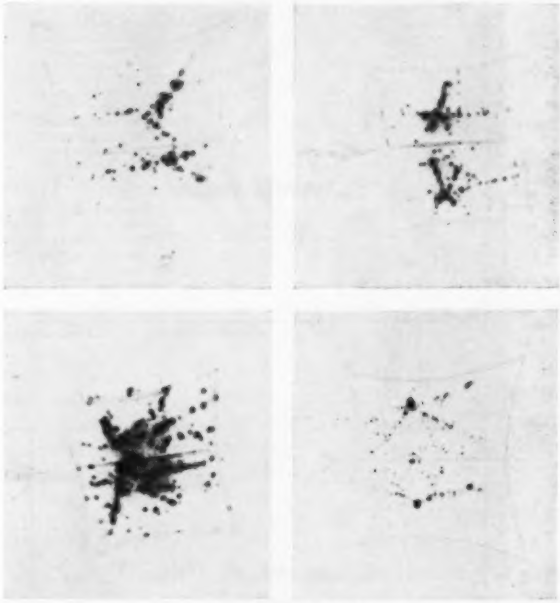

Fig. 3. Nuclear interactions initiated in a 2 by 2 by 4-in. sodium iodide crystal by high-energy mesons. Each photograph contains two 90° stereo images side by side. The scintillator image outlines have been sketched on the film with pencil. A system using a WL7257 plus three RCA C73458 tubes was used. The extreme pincushion distortion of the image and loss of resolution at the edge of the field is evident.

An alternative system for scintillator viewing employs filaments of plastic scintillator. In this system, shown by diagram (Fig. 6), the scintillator filaments pipe light to the image-tube cathode through a faceplate made of glass fibers. Stereoscopic viewing is achieved by using filaments stacked in layers with alternate directions in successive layers so that two image-tube systems are used, one for each of the 90° stereoscopic images. The system solves the depth-of-field problem present with the homogeneous scintillator of sodium iodide. However, in general the chamber area may be no larger than the photocathode area, and image tubes with glass-fiber cathode envelopes have only recently been successfully fabricated. The plastic scintillators of which such filaments are fabricated give off only about 10% as much light per unit particle path length as the inorganic (sodium iodide) crystals. Consequently the requirement of recording single photoelectrons from the cathode of the first image tube remains. The advent of glass scintillator filaments may make possible scintillation chambers of very fine (0.1 to 0.01 mm) spatial resolution; however, this program is still in the developmental stage.

D. Gating

Any image tube may be gated by pulsing the voltage on across a desired stage or a fraction of a stage (e.g., to a focusing electrode). In practice, we leave the first tube on continuously; pulse the second tube on for 2 to 10 μsec from an electronic signal from scintillation counters telling us an event of interest has occurred; and

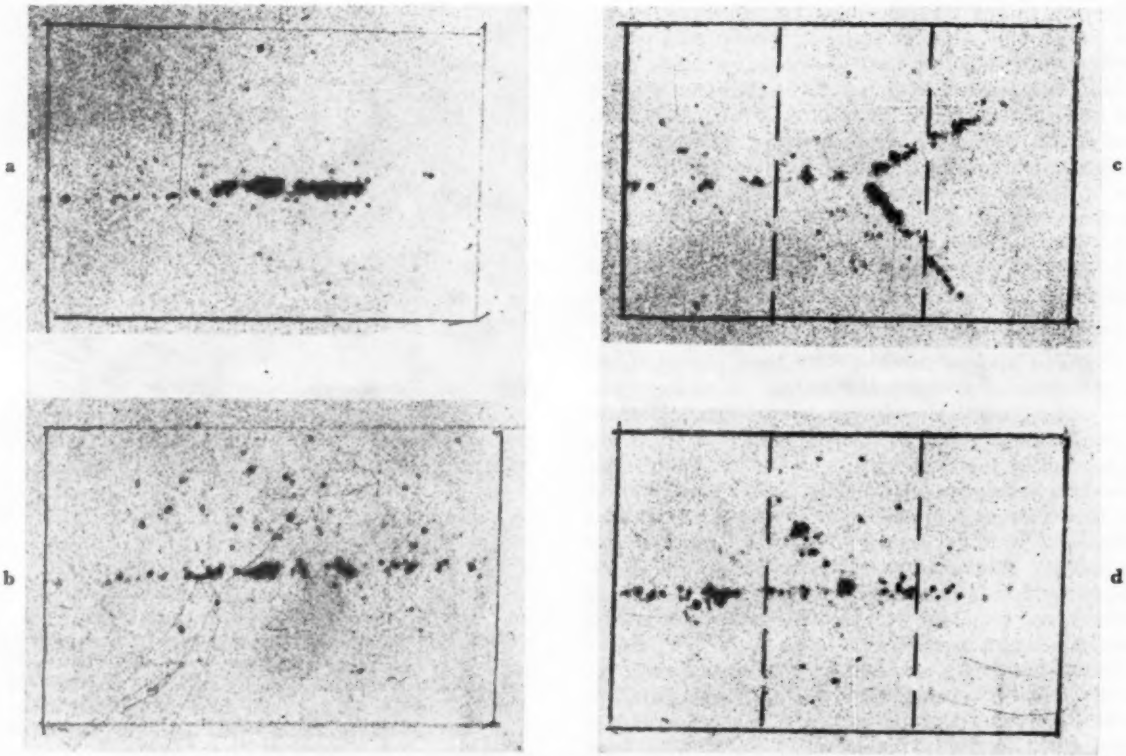

Fig. 4. Nuclear particles in a 2 by 4 by 6-in. array of sodium iodide scintillator viewed nonstereoscopically normal to the 4 by 6 surface using the system of Fig. 2. Figure 4a shows the track of a stopping proton, 4c is a scattering interaction and 4b and 4d are mesons penetrating the chamber.

pulse the later tube (or tubes) on for about 1 msec at the same time. Pulsing the later tubes does not affect the time resolution of the system but serves only to reduce noise light recorded on the film.

Although voltage gating at 10 to 15 kv of an entire stage is practical using high-voltage tetrodes it is generally simpler to gate the cathode or a focusing electrode. An image tube using electrostatic focusing may be turned off by biasing the cathode by 1 to 2 kv positive with respect to the first focusing electrode. Then by returning the voltages to their correct value for the desired gating time, time resolutions down to 1 μsec are readily obtained. Pulsing the cathode negatively by 2 to 3 kv is simplest electonically, using gating tetrodes such as the 3D21 and 6CU6. However, with some image tubes such as the RCA C73491 the cathode resistivity retards the effective gating speed. With such tubes, we have employed a 3-kv positive pulse, using a thyratron circuit applied to the focusing electrode. Single-stage image tubes, manufactured by RCA, Rauland and Du Mont, have been made with the inclusion of a gating grid, allowing gating pulses of only 200 v or so. To date, such grids have not been available in the high-gain, multistage tubes.

The timing sequence of events in our system, then, starts with the passage of the particle through the scintillator. Light from the scintillator (given off with a characteristic time constant, for sodium iodide, of 0.25 μsec) causes photoelectrons from the first image-tube cathode to excite the P15 phosphor of that tube. Light then comes off from that phosphor with a "hyperbolic" decay, roughly represented by a time constant of 2 μsec. Meanwhile an electronic signal from auxiliary scintillation counters pulses on a gate to the focusing electrode of the second tube for 2 to 10 μsec. The total delay from the time the particle passes through the scintillator to the time the second tube is gated on is about 0.4 μsec. Owing to the hyperbolic character of P15 phosphor, only about half of the total light from the phosphor is accepted under these gating conditions.

The rate at which successive events may be recorded is limited in our system to the film advance time. If there were a motivation for so doing, repetition rates corresponding to a picture every few milliseconds could be achieved.

In summary, our system records images corresponding to 1000 or less photons on a 5-in. diameter image plane with a time resolution of 2 to 10 μsec and a system of electronics capable of deciding, after the light arrives, whether or not to record this image.

E. Other Systems

Except for the use of organic scintillator filaments, rather than sodium iodide single crystals, the systems in use by other physicists are similar to those above described. However, the M.I.T. and Princeton groups have employed intensifier image orthicons such as the RCA C73477 in place of the final image tube, lens combination and film. As the ultimate sensitivity of the image orthicon (for a reasonable signal-to-noise ratio) is comparable to that of fast photographic emulsions (2×10^8 photons/sq cm) a reduction in the number of intensifier stages is realized only through reduction in the losses arising from optical coupling. The advantage of

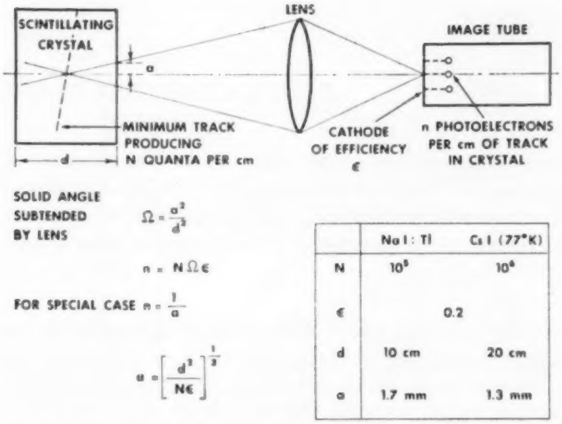

Fig. 5. Schematic of the quantitative problems of track recording in sodium iodide in a homogeneous chamber. The high scintillation efficiency of cesium iodide at low temperatures has so far been obtained only with very small crystals.

these systems lies in their ultimate ability to record automatically the picture information in digital form (e.g., magnetic tape), a form in which it may be handled directly by electronic computers. Thus in the future it is possible that a "picture" may never be observed.

II. Extensions of the Technique

In earlier papers Zavoiskii[3] describes a 5-stage, magnetically focused tube containing gating and deflection electrodes between the first cathode and the following stages. The deflection electrodes permit one to sweep a small image across the field with writing speeds characteristic of oscilloscopes. The one-stage gated tubes referred to above may also be used in this way, either to record a swept image, or (in conjunction with the gating grid) to take closely spaced short exposures and present the images side by side on the anode. Thus 16 exposures, each of 0.1 μsec, spaced by 2 μsec, can in principle be recorded.

These systems are not useful in our case where the phosphor of the first tube acts as a short-period storage while electronic logic decides whether or not to record the event. Because of the essential delays in counter electronics, it is doubtful whether this storage time can be made less than 0.2 to 0.1 μsec, so that 1 μsec is a reasonable limit to the time resolution of our device in its present form. It would be possible, however, to construct a magnetically focused image tube in which electrons would "drift" for 1 or 2 m at energies of 25 to 100 v. In this fraction of a microsecond the counter logic could initiate a postacceleration pulse to record the event or

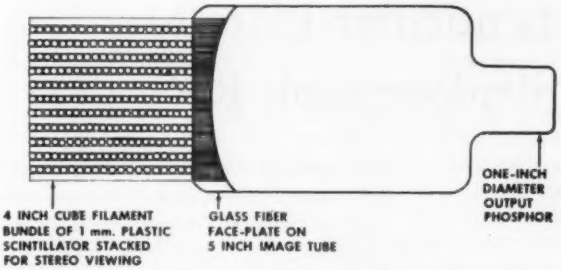

Fig. 6. Schematic of filamentary-chamber and image-tube system showing glass fiber optic coupling of the scintillator filaments to the photocathode.

not. With such a system, time resolutions might be pushed to as low as 10^{-8} sec. Below this, the transit time spread of particles and light across a scintillator becomes an important factor.

III. Conclusions

Image-intensifier tubes permit the recording of very faint images with microsecond time resolution. This technique is already proving useful in nuclear physics research and may find wider application in other fields. The system resolution remains the most serious limitation, but this stiuation is steadily improving and the advent of magnetically focused image tubes should allow pictures of at least television quality.

The time resolution of the system is limited in our application by the necessity of judging *ex post facto* whether or not an event is to be recorded. The general system concept is capable of time resolution ultimately limited by effects such as the transit times of light from various parts of the object.

Thus we believe we have in hand a technique which may find interesting and unique application in many areas of science and technology.

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Lenticular Plate Multiple Picture Shadowgraph Recording

By J. S. COURTNEY-PRATT

New apparatus has been built using image dissection principles and spark illumination. It can take a sequence of twelve shadowgraphs, each of exposure duration less than 1 μsec, and with the intervals between successive pictures anything convenient from a few seconds to 2 μsec. The resolution is 600 lines across the field each way. An alternative system using lenticulated film allows one to take small pictures with a resolution of 25 lines/mm. A number of ways are described of unscrambling the composite records.

Spark Shadowgraphs

It is possible to take pictures of objects that are not self-luminous by using a light source of short duration. If the object is faintly self-luminous, or if there is weak ambient lighting, it is still possible to take pictures of the phenomenon provided the flash source is sufficiently bright, and provided we use some form of capping shutter to prevent unwanted fogging of the film.

For pictures taken with the aid of a spark or flash, one may use an ordinary box camera which forms a real image of the object on the photographic emulsion. An even simpler arrangement is possible. We may if we wish simply record the shadow of the object. We would place the film a convenient distance from the light source, and trigger the source when the object is between the source and film.

The advantages of such a method are very considerable. The apparatus is fundamentally simple, and can be relatively cheap. As it is possible to obtain light sources with effective durations of less than a microsecond, image blur due to movement of the object can be kept small.

The object must usually be some little distance from the film. A point source of light would cast a sharp shadow. Practical light sources have a finite size, and so we do get a penumbra around the real shadow. This reduces definition, and a great deal of effort has been expended trying to produce bright brief light sources as small as possible. Diffraction of light at the edges of objects will also cause some lack of sharpness of the shadow cast. One usually endeavors to minimize the blur due to the combined effects of penumbra, diffraction, image movement, and granularity of the emulsion.

Figure 1 is a spark shadowgraph taken by Fayolle and Naslin.[1] The most obvious feature of the picture is the extraordinary detail and resolution that has been attained in spite of the rapidity of the motion of the object. Next, we note that as well as the silhouette of the object, the shadowgraph has recorded a clear picture of the position of shock waves. This is a general advantage. Changes in density of a transparent medium can be recorded, and one can deduce quite a lot about the density distribution by a study of the intensity pattern in the shadowgraph. Specifically, shadowgraphs show most effectively those regions where there are sharp changes in the density gradient.

Suppose we wish to obtain several pictures of an object at short intervals. It would be possible to fire a flash

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Fig. 1. The detail and resolution that can be obtained with simple spark shadowgraphs. (Courtesy of P. Fayolle and P. Naslin)

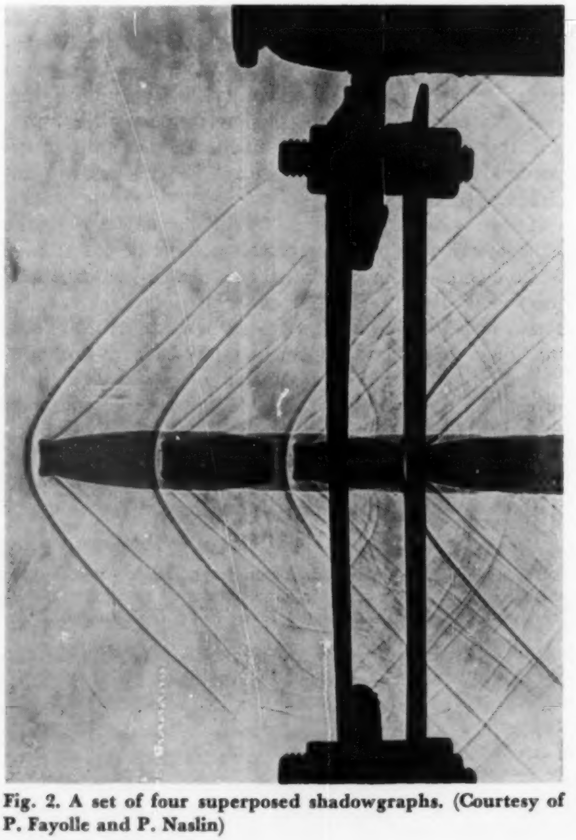

Fig. 2. A set of four superposed shadowgraphs. (Courtesy of P. Fayolle and P. Naslin)

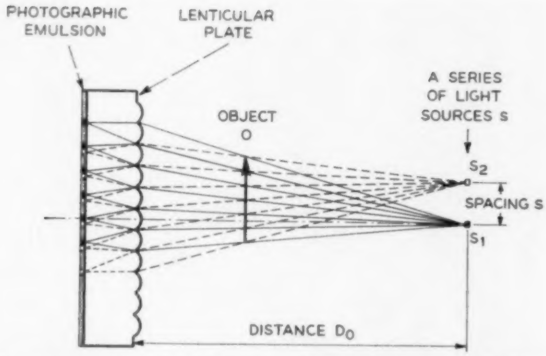

Fig. 3. A possible layout for recording a sequence of shadowgraphs using the lenticular plate image dissection method.

source several times, and to record the several silhouettes all on the one plate or film. Figure 2 shows a record of this kind.[1] For objects that are of known shape or events that are simple, it is reasonably easy to determine which parts of the composite superposed picture related to which exposure. The more complex the event, the more troublesome the ambiguities are. In any case the exposure latitude for each picture is reduced in direct proportion to the number of pictures we superpose. We might note however that multiple exposures on the one plate are less confusing if the object to be studied is much smaller than the field of view and is moving across the field during the sequence.

Dissected Shadowgraphs

There are many occasions on which we wish to photograph a complex event. Superposed pictures would lead to ambiguities which we could not resolve. Some years ago I suggested a new method which would allow one to record a number of shadowgraphs. Subsequently one could study each of these pictures separately without being troubled by interference between them.[2] Figure 3 is a diagram of a possible optical layout. A source of light S_1 casts a shadow of the object O. Instead of letting this shadow fall directly on a plate or film, I interposed a plate embossed with a large number of small lenticulations. In the simplest case these could be cylindrical lenslets. Each would then focus the light that fell on it to a narrow line image element. I placed a photographic plate at the focal plane of the lenticular plate. The photographic plate would record a dissected image of the object. That is, the image of the object was made up of a large number of narrow lines, instead of being a picture with continuous tone variation. The resolution would then be determined by the number of lines that went to make up the whole image. If now we fired a second flash source S_2, it also would cast an image of the object on to the lenticular plate. The light that fell on the lenslets would again be focused to an array of line image elements. If the source S_2 was displaced a distance s from the source S_1, the line image elements that went to make up the second picture would be displaced from the line image elements that went to make up the first picture. If the width of the line image elements was ϵ, and the pitch of the lenslets was p, the number of separate pictures that we could record without any double exposures would be p/ϵ.

Instead of using a lenticular plate embossed with cylindrical lenslets we could use a plate embossed with spherical lenslets. Such a plate is difficult to make. It is possible, however, to use two plates embossed with cylindrical lenslets, and to mount these with the axes of the lenslets crossed at right angles. Such a pair of lenticular plates acts much the same as would a plate embossed with spherical lenslets. As a practical detail, it is necessary to choose the two lenticular plates of the pair with slightly different focal lengths. The plate with the longer focal length is placed closer to the light source and the spacing between them is adjusted until the best point foci are obtained.

The lenticular plates that I used were supplied by R. Marilhet of Photographie en Relief, 152 Avenue des Champs Elysee, Paris. I would like to express my thanks to him for his cooperation and interest. These plates consist of a sheet of glass covered with a thin layer of plastic. The plastic is embossed in a heated press by a metal die with an array of cylindrical lenslets with a pitch spacing of 25 per centimeter. The focal length of the lenslets is approximately 1.5 mm. The precision of manufacture of the plates is of an extremely high order, and their resolution approaches the diffraction limit. If a single plate is illuminated at normal incidence with a collimated beam of white light, the cylindrical lenslets produce line images. The width of these lines at half intensity is less than 1/120 of the pitch spacing p of the lenslets. With a pair of plates with their axes crossed at right angles, each of the "spherical" lenslets will resolve 60 equally spaced line pairs within 0.8 p in both field dimensions. This can be demonstrated by direct photography on Kodak Maximum Resolution plates.

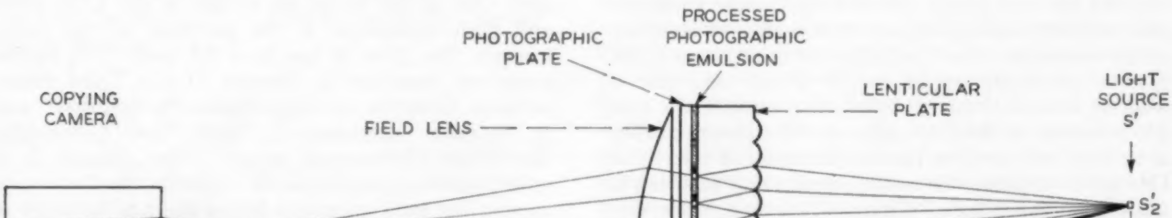

Fig. 4. An experimental arrangement for unscrambling the composite record taken with apparatus of the kind indicated in Fig. 3.

Using such a pair of lenticular plates the image elements would be small dots. If again we take the width of the elements to be ϵ, the number of pictures that ideally could be recorded without double exposures would be $(p/\epsilon)^2$. Although the width of the image element ϵ can be very small, in practice it is broadened for a number of reasons. If the light source had a finite size, this would contribute to the width of the image element. The photographic emulsion because of its finite resolution and because of halation and turbidity broadens the image element. Diffraction of light and imperfections in manufacture of the lenslets broaden the image element. If the recording emulsion is not exactly in the focal plane, the image element is broadened. In practice it is possible to keep the width of the image element a good deal less than 1/20 of the pitch spacing. It proves possible to record with a fine-grain emulsion about 300 separate pictures, and with a faster and coarser emulsion about 50 or 100 pictures.

Light Sources

All of the light that falls on a cylindrical lenslet is focused into a line image element. Thus the illumination at the emulsion is some 20 times greater than it would have been if the lenticular plate had been omitted and one had attempted to take an ordinary spark shadowgraph. With a point-focus pair of lenticular plates, all the light that falls on an area p^2 is concentrated into an area ϵ^2. The gain in illumination is a factor of about 400. It is thus possible to use weak light sources. This is a great advantage as it is much easier to obtain very brief light sources if they can be of small energy. In some of my earlier work I showed that it was quite possible to use the light that was given out by the spot on a cathode-ray tube.[2] Using a small cathode-ray tube with an anode potential of 5 kv, it was possible to obtain shadowgraphs with the exposure time for each of 5 μsec. Higher anode potentials and shorter decay phosphors would obviously allow one to obtain considerably shorter exposure times.

Recently I built new apparatus of this same general kind, but using small spark sources. At first, I used a single lenticular plate and recorded 12 line image elements behind each lenslet. Later I mounted a pair of lenticular plates, and I now record 12 point image elements behind each lenslet. The inherently higher brightness of the point image elements allows the use of finer grain plates and a longer working distance between the spark sources and the lenticular plates. As this working distance is long, one can use a large lenticular plate without running into any difficulties from obliquity of the incidence of the light. The lenticular plates in the present apparatus are 30 cm $\times$ 24 cm and give a working area of 24 cm $\times$ 24 cm. The resolution is thus 600 points across the field each way. The picture quality is at least as good as current commercial television. One might compare this resolution with that achieved in an average commercial cinema where one rarely can resolve more than 350 line pairs from top to bottom of the screen. In fact, the resolution compares very favorably with the usual standards in high-speed photography where a resolution in excess of 200 line pairs across the field is unusual.

It appeared that there might be difficulty in keeping the photographic emulsion in the focal plane of the lenticular plates. Ordinary photographic plates of this size did give trouble. However it is now possible to obtain microflat plates such as are used in photogrammetry. For these plates the emulsion is coated on selected plate glass. The manufacturer's flatness specification is 0.0002 in./in. For all of these plates that I have used, the departure from a true plane all over a 10-in. $\times$ 10-in. square has not been greater than 0.001 in. This means that one can keep the emulsion in the focal plane within the required tolerances.

Fig. 5. One picture unscrambled by the method shown in Fig. 4 from a sequence of 12 recorded at intervals of 2 μsec. The sequence shows the movement of fragments and the progress of cracks after a bullet had been fired through a glass Petri dish.

A wide variety of light sources could be used. For the present set up, I am using equipment that has been built by the Laboratoire Central de l'Armement.[3] The equipment will provide 12 air sparks, or will provide 12 flashes in small xenon-filled tubes. The stored electrical energy for each flash is 1 joule. The sources can be fired at any of a number of precise intervals from 2 μsec to 2 msec. The firing frequencies are controlled by a number of crystal oscillators. Longer intervals can be produced by using an external oscillator. The exposure time for each picture with spark illumination is about $\frac{1}{4}$ μsec; with flash illumination, about $\frac{1}{2}$ μsec. One of the major advantages of the LCA spark and flash equipment is the precision of the firing instants. The jitter is less than 0.1 μsec. This equipment was described by Devaux at the Third International Congress on High-Speed Photography[3] and is available commercially from the Laboratoire Central de l'Armement, Arcueil, Seine, France. It is quite possible to produce much briefer sparks of adequate energy, but such apparatus is not likely to be quite so convenient to use, as the pulse circuitry would then need to be mounted much nearer to the spark gaps.

Figure 4 is an optical layout for unscrambling the composite record. Figure 5 is a picture taken with the equipment showing the kind of resolution that is possible. It is one from a sequence of 12 pictures taken at intervals of 2-μsec. Figure 6 shows a somewhat similar sequence — in this case of the inevitable electric light globe and

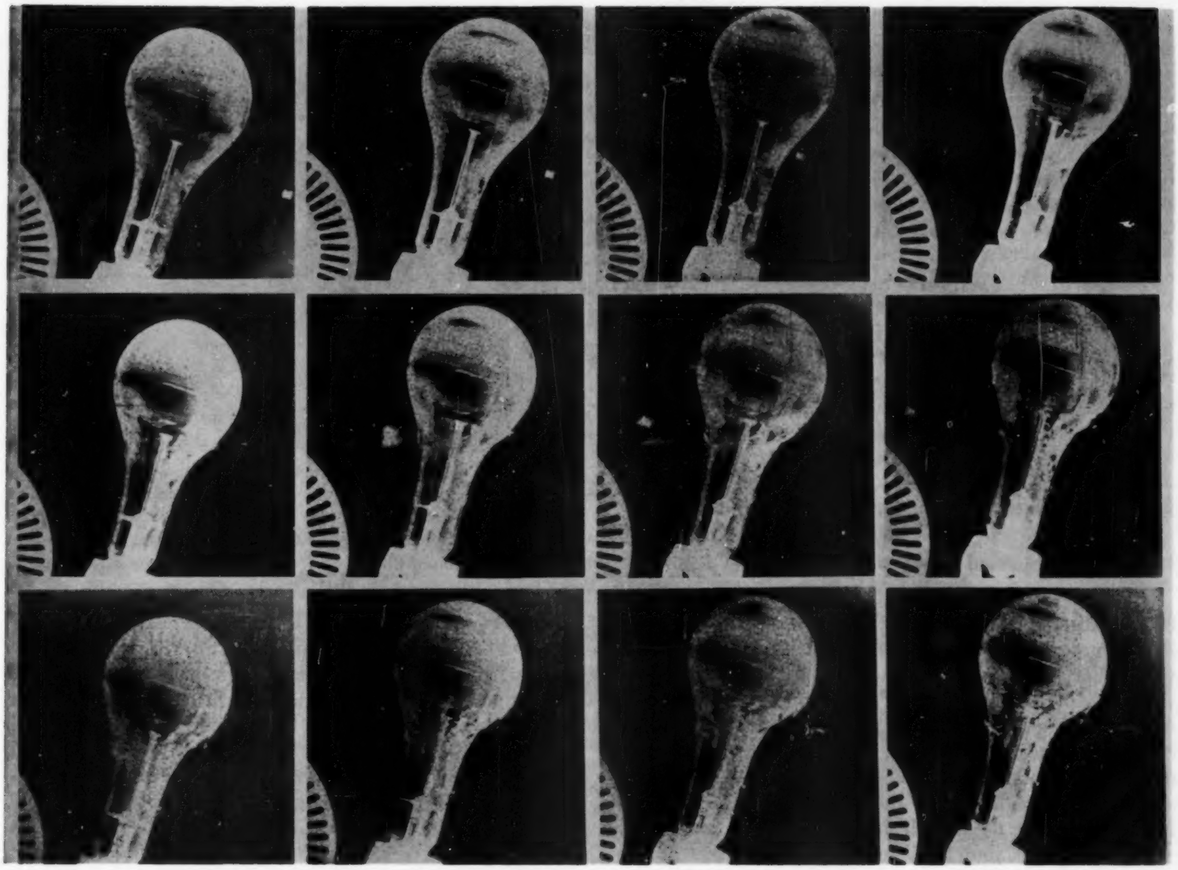

Fig. 6. A sequence of 12 pictures taken with equipment of the kind shown in Fig. 3, and unscrambled as shown in Fig. 4. The pictures were recorded at 5000 frames/sec. The exposure time for each is $\frac{1}{4}$ μsec. One can see the fracture of an electric light globe by a small air gun bullet which was traveling at 400 ft/sec.

bullet breaking it. The sequence was recorded at 5000 frames/sec. The exposure time for each is, as before, $\frac{1}{4}$ μsec.

Stereoscopic Photography

Instead of triggering all the light sources in sequence, it would be possible to trigger them in pairs. One would then, obviously, record pairs of simultaneous photographs. The viewing base would be equal to the distance between the pairs of sparks. The unscrambled images would comprise a sequence of stereoscopic pairs, and these could be measured or could be viewed in a stereoscope in the usual way.

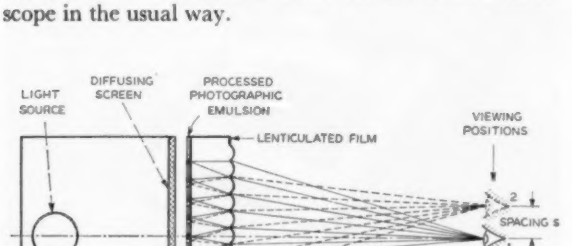

Fig. 7. A simple method of viewing any one frame when a sequence has been recorded on lenticulated film.

An Alternative System

In the system described above the photographic plate was separate from the lenticular plate, or plates. It was necessary to use glass plates to maintain the required dimensional stability. However, if the emulsion is coated directly on the lenticular plate, the tolerances on freedom from overall distortion may be considerably relaxed. The emulsion must not move grossly with respect to the lenticulations; but an overall stretch of say $\frac{1}{2}$% would not matter unduly, provided the emulsion and lenticular plate both stretch by the same amount.

Some time ago Eastman Kodak Co. developed a lenticulated film, Type 5209.[4] The film is 35mm wide; the lenslets are cylindrical, with their axes running across the width of the film; the pitch spacing of the lenslets is 1/250 cm. A very fine grained emulsion is coated on the film on the side opposite to the lenticulations. The thickness of the film is such that the emulsion is in the focal plane of the lenslets. A piece of the Type 5209 film can be used in the way illustrated diagrammatically in Fig. 3. The individual pictures could be unscrambled just as before (Fig. 4). However, the ease of handling these small pieces of film means that some other possible methods of unscrambling may perhaps be more convenient. Fig. 7 shows the simplest of the methods. After processing, the piece of film is held flat, illuminated by a diffuse source from the emulsion side, and viewed

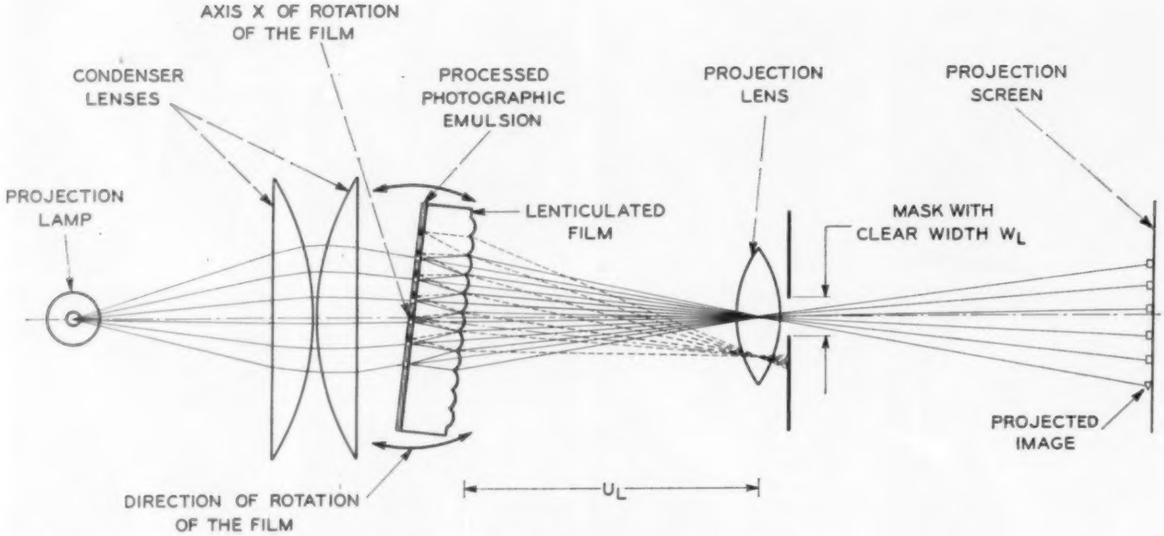

Fig. 8. A simple method of projecting a sequence of pictures by tilting the lenticulated film.

from a distance equal to the distance D_0 between the light source and the film when the pictures were being taken. For one position of the eye, only one picture is visible. Moving the eye along the film a distance equal to the spacing s between the light sources allows one to examine the adjacent picture. Similarly, a small rotation of the film about an axis lying in the plane of the emulsion and perpendicular to the plane of the diagram in Fig. 7 allows one to view all the pictures of the sequence.

If stereo pairs had been recorded, either one of the pair could be seen by appropriate placing of the eye. If the "viewing base" had been made equal to the interocular distance, it is obvious that one could view a stereo pair as a proper stereo presentation, merely by looking with both eyes at the record from the correct distance. Successive stereo pairs could be examined by moving both eyes parallel to the length direction of the film, or by slightly tilting the film.

Another method of unscrambling the record, which is in fact very similar to that just described, is shown in Fig. 8. A lens is placed at a distance U_L from the film. U_L should be equal to D_0; but as the format to be projected is small, U_L and D_0 need only be approximately equal. The focal length F_L of the lens is less than U_L and so should be a little shorter than the distance D_0. If the width W_L of the lens (or a mask) in the plane of the diagram is less than the spacing s between adjacent light sources when the record was being made, then the lens will project one only of the pictures of the sequence recorded. If the film is rotated about an axis X lying in the plane of the emulsion and perpendicular to the plane of Fig. 8, the sequence of recorded pictures will be projected by the lens onto a screen placed at the conjugate focus of the lens. A small device has been made, and is shown in Fig. 9. It will fit in any projector that takes $3\frac{1}{4}$-in. $\times$ $3\frac{1}{4}$-in. slides, and will hold a 2-in. $\times$ 2-in. 35mm slide. This slide can be tilted about an axis lying in the plane of the emulsion by simply pulling on a wire attached to a lever.

A few experiments were undertaken to demonstrate that these methods of recording and unscrambling were quite practicable. A strip of Type 5209 film was held flat between two pieces of Lucite sheet. It was supported in a horizontal plane, emulsion up, 22 in. above an array of eight spark sources. The distance s between adjacent sparks was 1 in. The firing sequence could have been simply from 1 to 8 but in these particular records it was 1, 3, 5, 7, 2, 4, 6, 8. This provides a somewhat severer test of the system as, if there were any undue spread of the images, ghosting would be much more evident. It was found that eight independent pictures could be easily recorded. When the emulsion was examined with a microscope, the line image elements could be clearly resolved. If a small amount of ghosting were tolerable, double the number of frames could be recorded. Figure 10 is a 7 $\times$ enlargement of a small section of one of the pictures after unscrambling from the composite record on a length of Type 5209 film. It is one of a sequence of eight pictures of a small air gun pellet that was moving at 400 ft/sec. The interval between successive pictures was 20 μsec, and the exposure time for each was $\frac{1}{4}$ μsec.

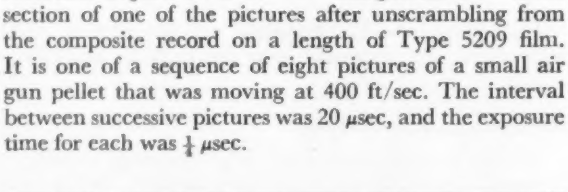

Fig. 9. A photograph of a small tilting device that will fit in conventional still projectors and allow the projection of a sequence of images.

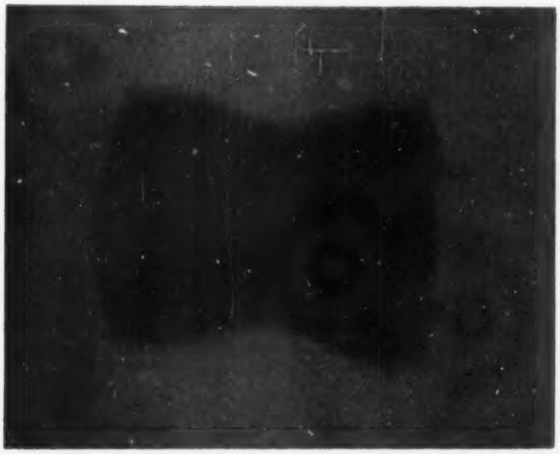

Fig. 10. An enlargement of a small part of one of the eight shadowgraph images recorded in a sequence on Type 5209 lenticulated film. The exposure was $\frac{1}{4}$ μsec. The interval between frames was 2 μsec. The hour-glass shaped bullet was 0.22 in. in diameter.

The sequence was also projected at the Congress. The distance D_0 as stated was 22 in.; the focal length of the projection lens, 20 in. To insure that only one picture at a time was projected, it was necessary to put a paper mask in front of the projection lens. The width W_L of the slot in the mask could not be over 1 in. The height of the aperture (which did not need to be restricted) was about 4 in.

The resolution in the length direction of the film is limited by the pitch spacing of the lenslets and is 25 lines/mm. The resolution in the transverse dimension is limited by the emulsion, by the source size, by penumbra, and by diffraction. The actual diameter of the projectile in Fig. 10 is 0.22 in. The sharpness of the image shows that detail very much smaller than this can be recorded. In this instance the limit was set mostly by penumbra, as the sparks were several millimeters long.

This series of tests confirms that fast sequences of high-resolution pictures can be taken with extraordinarily simple equipment.

Summary

It is possible to record the silhouette of an object directly on a photographic plate using a point source of light. With a spark or flash source, the exposure duration can be a fraction of a microsecond. A short succession of discharges can give a short series of shadowgraphs; but in the usual arrangements of apparatus all the pictures of the series are superimposed. If a plate embossed with a large number of small lenslets is placed just in front of the photographic plate, it is possible to arrange that each of the series of (dissected) shadowgraphs is recorded as a separate array of small image elements. These pictures can subsequently be unscrambled and examined individually. Apparatus has been built using this principle to take a series of 12 shadowgraphs, each of exposure duration less than a microsecond and with intervals between the pictures anything convenient from 1 sec to 2 μsec. The resolution of these shadowgraphs is 600 lines across the field each way.

It would be possible to increase the number of discrete pictures in a sequence to 144 if this large number of spark sources were provided. Equally, half as many stereoscopic pairs could be recorded.

An alternate system makes use of Eastman Kodak Type 5209 film. Sequences of eight pictures with a resolution of 25 lines/mm have been recorded. The exposure time for each frame was $\frac{1}{4}$ μsec, and the intervals between successive pictures, on different occasions, were 2 μsec and 20 μsec.

A small device has been made to hold and tilt a piece of lenticulated film on which a sequence of dissected pictures has been recorded. With the aid of this device it is possible to project a short motion-picture sequence using an ordinary still projector.

Acknowledgments

I would like to thank J. W. McLaughlin for his extensive help with the experimental work, particularly that relating to the unscrambling techniques. I would also like to thank J. Kuhne of Bofors, AG, for drawing to my attention the Type 5209 film which he was using so successfully in his small Nipkow Disc Aperture Scanning Camera.

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Development of a Photoelectronic Shutter Tube

By LEONARD MANDEL

A photoelectronic image tube usable as a high-speed shutter is being developed. The tube is a magnetically focused image intensifier, in which the photoelectron beam is made to pass through two metal meshes mounted a few centimeters from the photocathode. The first mesh acts as a control grid while the second serves as an auxiliary electrode. Its introduction increases the control sensitivity and makes the electron focus less dependent on the control mesh potential. Shutter tubes having an on-off control voltage range of about 3 v and a resolution of 15 to 18 line pairs per millimeter have been made. The loss of electron current due to the meshes is less than 20%. Curves are presented showing the electron penetration under various conditions of cutoff.

Image converters lend themselves naturally to development as high-speed shutters, not only because of their intrinsically low inertia, but also because of the intensification of which they are, in principle, capable. Several applications of commercially available tubes to high-speed photography have already been described.[1,2,3] All of them suffer from the disadvantage that a large triggering voltage, of the order of several kilovolts, is normally necessary to turn the tube on and off. While this is an order of magnitude improvement over the Kerr cell, it still makes shuttering in the millimicrosecond region extremely difficult. The present development of a grid-controlled image converter was undertaken in an attempt to produce a shutter tube which could be adequately controlled by a much smaller signal. Several tubes capable of being switched on and off by a pulse of 3 to 4 v, and having an intensification of 5 to 10 for blue light, have been made. Their behavior is described, in more detail, in the following sections.

The Single Mesh Tube

The image converters used for this development were of the type already described by Zacharov and Dowden,[4] except that the end-window carrying the fluorescent screen was conventional. The photoelectrons leaving the SbCs cathode are accelerated by a series of circular electrodes, in the form of platinum rings painted on the inside of the glass envelope, to strike an aluminum-backed fluorescent screen of silver activated zinc sulfide. The tube is magnetically focused by a long solenoid surrounding it and is normally operated at the second focus with an approximately uniform axial electric field.

The control grid, in the form of a thin electro-formed copper mesh, was inserted between the first and second ring electrodes. It was mounted on a metal ring and covered a field of 2 to 3 cm in diameter. The mesh had a geometrical shadow ratio of 35 to 40% and a mesh density of 200/cm.

During the activation of the photocathode, the mesh was covered by the cathode plate to prevent cesium from reaching the mesh and penetrating into the high potential section of the tube. After processing was complete, the cathode plate was released, inverted, and dropped onto the front end plate where it was again held by a catch mechanism. The technique has already been described.[4] Only the portion of the tube preceding the mesh was cesiated; and leakage resistances of the order 1 megohm may be found between cathode, first accelerating ring and mesh.

The first accelerating ring was normally maintained at a potential V_{a_1} of 30 v to 100 v positive relative to the cathode. It provided an accelerating field at the cathode which assured saturation emission with only a few volts V_g on the mesh. The portion of the tube from mesh to anode was operated as a conventional image section. It was found that holding the mesh at cathode potential ($V_g = 0$) was sufficient to cut off the beam and that the cathode current I_K reached its saturation value for V_g between 4 and 5 v.

The detailed behavior is shown in Fig. 1 in which cathode current I_K, anode current I_A and mesh current

Presented on October 18, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by L. Mandel, Imperial College of Science and Technology, University of London, England.

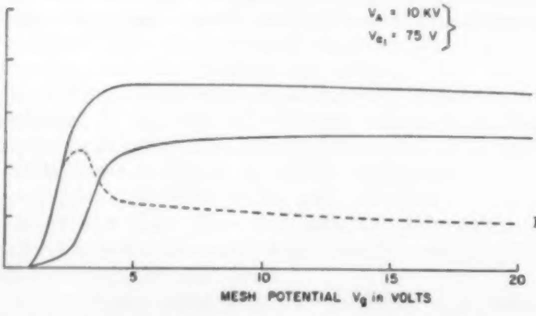

Fig. 1. The current distribution as a function of mesh potential for the single mesh tube.

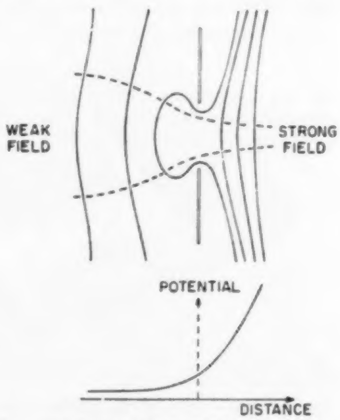

Fig. 2. The equipotentials of the one-aperture lens.

I_g are plotted as a function of mesh potential V_g. It will be seen that current flows for $V_g > 1$ v, but goes predominantly to the mesh at first. I_g passes through a maximum at $V_g \sim 3$ v and then falls. The anode current rises steadily; and by the time I_K first reaches its saturation value, the anode collects a fraction of the cathode current corresponding to the geometrical transmission of the mesh. But it is interesting to note that this situation does not last. I_g continues to fall and I_A continues to rise towards I_K with increasing mesh potential. By the time V_g reaches about 150 v, $I_g = 0$ and $I_A = I_K$.

This somewhat surprising result can be understood in terms of the focusing action of each elementary mesh aperture. The equipotentials of an electrostatic aperture lens having a weak accelerating electric field on one side and a strong field on the other side are shown in Fig. 2. The equipotentials bulge through the aperture and spread a little way along the surface of the electrode. When many such apertures are placed closely adjacent, as in a mesh, the region close to the mesh structure is practically field free and a strong focusing field extends towards the cathode for a distance of the order of the aperture dimension. As the mesh potential rises, the electrons are drawn towards the mesh and through the apertures.

Although the image brightness in this shutter tube is well controlled by the mesh potential, the focus depends fairly critically on V_g. The anode does not collect the full cathode emission I_K, at least for moderate values of V_g. Also, the preferential collection of the photoelectrons by the mesh for low values of V_g is rather undesirable. It means that, during the rise time of any trigger-on pulse applied to the mesh, the signal is substantially lost. This may be serious when a very-high-speed phenomenon is to be photographed. The solution is to use a very low shadow ratio mesh with the field penetration well controlled. The foregoing results on the current distribution suggest that a second mesh held at a sufficiently high potential may be desirable.

The Double Mesh Tube

A diagram of a double mesh tube based on the foregoing results is shown in Fig. 3. The meshes are again placed between the first and second accelerating rings. Both are screened from cesium during the activation of the cathode.

In a double mesh tube we have the choice of using either one as the control grid. Figures 4 and 5 show some

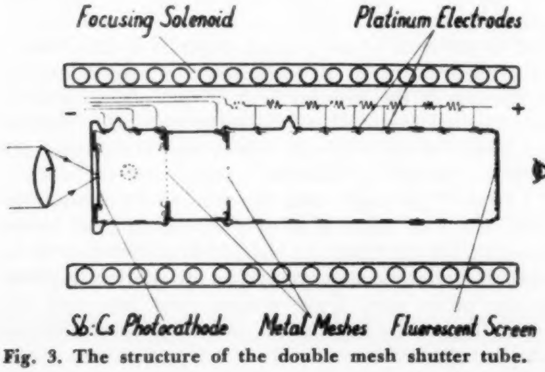

Fig. 3. The structure of the double mesh shutter tube.

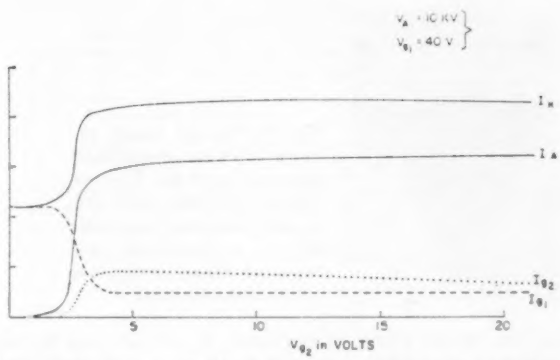

Fig. 4. The current distribution as a function of V_{g2} for the double mesh tube.

measurements made under both conditions. In this particular tube the second mesh was of the kind described earlier. The first one, however, was made of coarsely woven tungsten wire. It had a mesh density of only 15 to 20/cm and a shadow ratio around 5%.

Consider first Fig. 4 in which the various electron currents are plotted against the second mesh potential V_{G2} while the first mesh acts as an accelerating electrode and is held at $V_{g1} = 40$ v. It is clear that cathode current cannot be cut off under these conditions; and, when V_{g2} is zero or negative, the electron emission is collected by the first mesh. In the presence of an axial magnetic field confining the electron trajectories, the cathode emission falls below its saturation value by an amount depending on the shadow ratio of the first mesh. As V_{g2} rises, I_K increases to its saturation value while I_{g1} falls; but the first mesh continues to collect current as long as it finds itself at a potential maximum, i.e. above cathode and second mesh potential. I_{g2} passes through a maximum around $V_{g2} \sim 5$ v and then falls slowly with V_{g2} increasing in the characteristic manner found earlier with the single mesh tube. Although the anode current I_A rises more sharply than in Fig. 1, it does not approach I_K very closely because of the small value of V_{g1}.

Now consider Fig. 5 in which the first mesh is the control grid while the second one acts as accelerator. By making $V_{g2} = 75$ v, the current I_{g2} is kept very small as expected from earlier results. The first mesh is no longer at a potential maximum and therefore collects only a small amount of current determined by its shadow ratio. The cathode current is predominantly collected

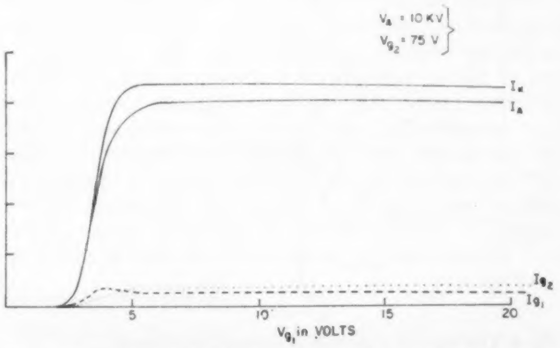

Fig. 5. The current distribution as a function of V_{g1} for the double mesh tube.

Fig. 6. Typical image obtained with the shutter tube operated at 10 kv. The resolution is 15 line pairs/mm. A one μsec switching pulse of 10 v amplitude was repeated about 10^4 times to produce the picture.

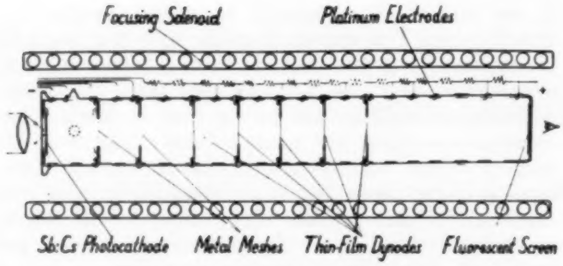

Fig. 7. The structure of the cascade intensifier shutter tube.

by the anode where it is wanted. It will be seen that a voltage swing of 3 to 4 v at the first mesh is sufficient to turn the tube on or off.

A number of image tubes of this type have been made. The later ones had electro-formed copper meshes also as control grids. These meshes had a mesh density of 80/cm and a shadow ratio of about 12%. The overall resolution achieved with this shutter tube was of the order of 15 line pairs/mm and image intensification of the order of 5 to 10 for blue light was obtained at the same time.

Figure 6 shows a resolution test chart obtained with one of the tubes under pulsed conditions. One-microsecond pulsed exposures were repeated approximately 10,000 times to produce the negative. The control voltage pulse of 10-v amplitude switched the first mesh potential between −2 v and +8 v.

The Cascade Intensifier Shutter Tube

One of the intended applications of this shutter tube is the photography of tracks of ionizing particles passing through a luminescent crystal, as first described by Zavoiskii et al.[5] The method has since been successfully demonstrated by Perl and Jones.[6] In order to achieve sufficient intensification for single photoelectrons to show up on the photograph, they were compelled to use a series combination of three image intensifiers coupled by large aperture lenses. On the other hand, a cascade intensifier based on the secondary emission principle, which has sufficient gain to allow single photoelectrons to be photographed directly, has recently been developed by Wilcock, et al.[7] It seemed desirable to mate the trigger section of the tube described earlier with this high-gain intensifier in order to produce a single tube capable of taking over the whole function.

Such a tube is illustrated in Fig. 7. The front end is of the type described earlier and is followed by five multiplying films transmitting secondary electrons with an average electron multiplication of 4 to 5 per stage. The output end of the tube shows the characteristic point scintillations corresponding to photoelectrons leaving the cathode.

Since the photoelectrons always cross the control mesh with quite a low velocity, there is a natural transit time of the order 10 to 20 mμsec (depending on V_{a_1}) from cathode to mesh. This is an advantage in the photography of luminescent particle tracks. It provides a "storage" of information while the decision is being made whether or not to photograph the event.

By using the electron multiplying section of this tube as a current amplifier, it is possible to make much more precise measurements of the electron current penetrating the control mesh in the region of "cutoff." Such measurements are presented in Fig. 8. They show that, at least for the higher values of the first ring potential V_{a_1}, the cutoff is by no means complete even with −15 v on the control mesh. On the other hand, with the ring at 35 v, the penetration is less than one part in 10^6 for $V_{g_1} = -5$ v. Smaller penetrations were not measurable with this technique.

The rather complicated behavior is not yet completely understood, but we believe that the explanation is again to be found in the shape of the equipotentials near the control mesh. With the mesh held below cathode potential, there is a field free region (neutral points) close to the mesh whose position depends on the relative strengths of the fields on either side. The equipotentials on the side of the stronger field always penetrate some way through the mesh to the other side. The position and height of the potential barrier encountered by any electron, therefore, depends strongly on the voltage V_{a_1}. When V_{a_1} is high, some electrons will penetrate the mesh and find themselves in a diverging field before encountering the potential barrier. It is therefore to be expected that some are captured by the accelerating field on the other side. Only modest ring potentials V_{a_1} should be used in applications in which a high extinction ratio is necessary.

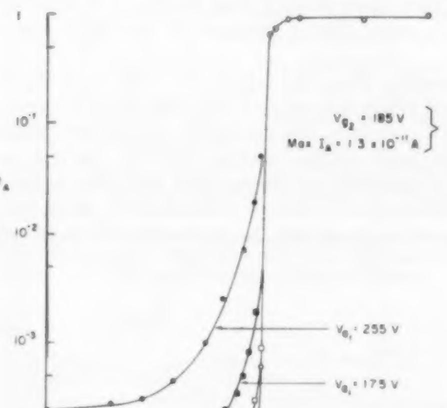

Fig. 8. The current penetration through the control mesh for different values of V_{g_1} and V_{a_1}. (By courtesy of Dr. W. L. Wilcock and Mr. D. L. Emberson.)

Acknowledgments

The author is grateful to Professor J. D. McGee for his interest and advice and to Messrs. Horvath and Magyar who were largely responsible for making the tubes. The cascade shutter tube shown in Fig. 7 is the work of Dr. W. L. Wilcock and his associates, Messrs. Emberson and Weekley. The author is grateful to them for permission to reproduce the results of their measurements.

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High-Sensitivity Television as an Aid to Low-Light-Level Photographic Recording

By BERNHARD A. BANG

High-sensitivity closed-circuit television equipment can be used as an aid to recording a scene where the effective exposure limitation is below the capability of direct photography. The monitor presentation is photographed by normal techniques. The effective speed of such systems has been increased rapidly during the past three years. Equivalent ASA ratings in excess of 100,000 are now available.

The sensitivity of a well-designed closed-circuit television equipment is determined primarily by the pickup tube and the optics. The most sensitive tube available for the past several years has been the image orthicon or its variations. The sensitivity has been increased to the point that the statistical variation in light photons received is a limitation. The characteristics of these tubes, mode of operation and relative sensitivity are discussed.

A BASIC requirement for photographic data recording is the availability of sufficient light. Frequently, the available light is insufficient for an exposure of the desired time. Therefore, some means is required to increase effectively the brightness of the scene as viewed by the recording camera. Closed-circuit television can frequently be used to provide this brightness amplification. The improvements in sensitivity of television equipment during the past three years have made this possible.

It is this technique which we wish to encourage by presenting some data on the relative sensitivity of several television pickup tubes and illustrating the performance possible with several examples.

Closed-Circuit Television Equipment

This paper considers only closed-circuit television in which light from a scene is continuously imaged on to a photosensitive pickup tube. In this tube, the light image is transformed into an electrical image and is then amplified and stored. A reading electron beam periodically removes the stored information on an element-by-element basis and converts it to an electrical video signal. This signal is further amplified and transmitted by wire to a display monitor where it may be photographically recorded.

Presented on October 18, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by Bernhard A. Bang, Friez Instrument Div., The Bendix Corp., Baltimore 4, Md.

In closed-circuit television, the designer, and sometimes the user, has considerable control in the choice of system variables such as the type of pickup tube, number of scan lines per frame, frame rate and bandpass. Notable variations are horizontal scan rates ranging from 225 to 2000 horizontal lines/frame, "slow scan" of several minutes per frame to fast scan of 100 frames/sec and system video bandpass ranging from several kilocycles to 35 megacycles. One other important variation is the use of integration and storage of an image inside the pickup tube. This will be described later.

A selection of the above parameters requires a choice between interrelated characteristics. The number of frames per second should be determined by consideration of flicker effects, motion in the scene, bandpass and compatibility with cameras. The number of horizontal scan lines per frame is usually determined by the required (and available) picture information content. The number of horizontal lines defines the maximum possible vertical resolution. Bandpass is then determined by the product of horizontal scan rate, frame rate and the desired horizontal resolution. Final selection is then usually made according to the availability of equipment which most nearly meets the requirements.

Sensitivity Limitations

The basic sensitivity limitation in television is the pickup tube. In general, bandpass controls the maximum possible resolution at high light levels, whereas various

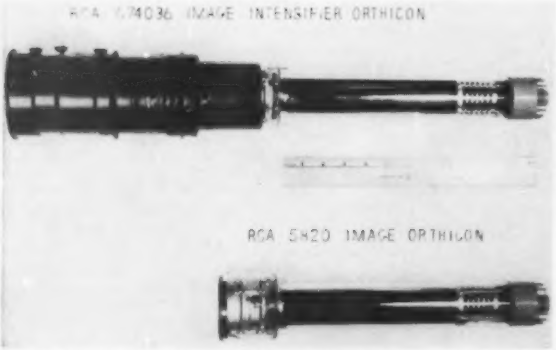

Fig. 1. Image intensifier orthicon (top) and image orthicon (bottom). (Courtesy of Radio Corp. of America.)

sources of noise control the resolution at low light levels. At the light levels considered in this paper, bandpass is seldom a limitation. At low light levels, the principal sources of noise are (1) beam current in the pickup tube, (2) preamplifier noise, (3) spurious signals and (4) keyed clamp noise.

Pickup Tubes

The most sensitive television pickup tubes are the image orthicon and the image-intensifier orthicon. These are the only ones considered in this paper. These tubes are shown on Fig. 1, the lower one being the image orthicon and the upper the image-intensifier orthicon. Many variations of these tubes are available, but most of the variations are internal and do not change the external configurations.

In the image orthicon, light is focused on the photocathode, where electrons are released and accelerated toward a target. Secondary emission takes place at the target, leaving an electrical image of positive charges on the target. Until recently, the targets used in the standard broadcast tubes, such as the 5820, were made of thin glass. These targets allowed a small amount of charge storage, or signal integration, up to approximately 1/60 sec. The signal is then read off by discharging the target with a scanned electron beam.

The sensitivity limitation in the image orthicon is the signal-to-noise ratio in the scanning electron beam. Since it would be quite difficult to reduce the noise in the beam, the most generally accepted technique of im-

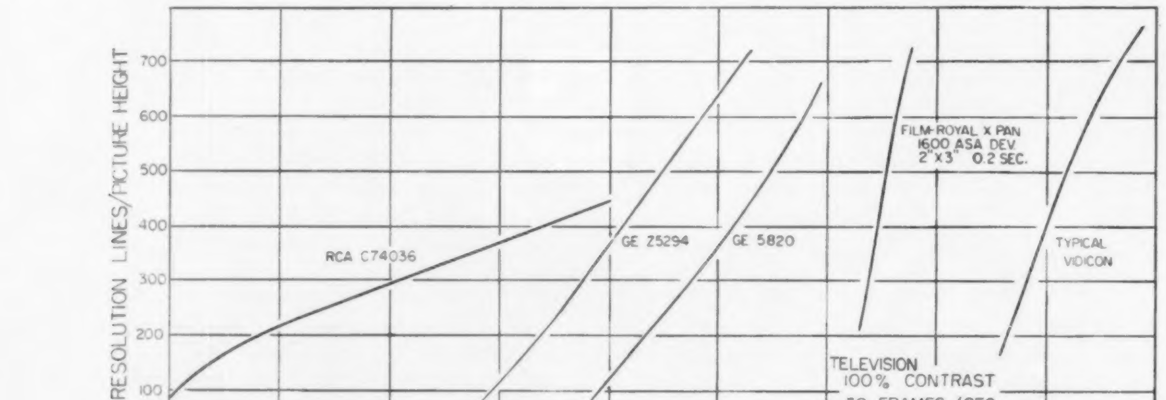

Fig. 2. Television tube vs. film sensitivity.

proving this ratio is to increase the signal level, or charge, at the target. One method is by adding an image-intensifier section to the front of the tube as shown in Fig. 1. Light falls on the first photocathode, releasing electrons which are accelerated toward, and are focused on, a sandwich screen. This screen consists of a phosphor layer on one side of a thin mica sheet and a second photocathode on the opposite side. The excited phosphor emits light which in turn releases electrons from the second photocathode. From this point on, the tube is similar to the image orthicon. Gain is produced in the intensifier section by accelerating the electrons from the first photocathode to the sandwich screen with a high potential.

Several other changes in the image orthicon may be made to improve its efficiency and those will in turn increase the signal-to-noise ratio in the reading beam. These changes are: (a) improvement of photocathode, (b) increase in secondary-emission ratio of target and (c) increase in storage capability of target.

Three years ago, a major breakthrough in sensitivity was introduced by the General Electric Co. when it developed an image orthicon using the magnesium oxide, thin-film target. This target had a higher secondary-emission ratio and improved storage capability.

Further improvements have been made in photocathodes. The tri-alkaline (S-20) photocathodes which have been developed have a practical improvement factor of two to three over the more common silver bismuth (S-10) photocathodes.

All three of these features — image-intensifier section, tri-alkaline photocathode and MgO target — have been incorporated in a few experimental tubes (type C74036) by the Radio Corp. of America. These tubes have given excellent results.

Relative Sensitivities

Figure 2 shows the relative sensitivity of the various types of tubes considered. Limiting resolution, specified as the total number of black-and-white lines resolved across the picture height (4:3 aspect ratio), is plotted against light level. To eliminate optics as a variable, light level is specified in terms of foot-candles on the light-sensitive surface at the image plane.

On the right hand side of Fig. 2 is the 5820 which has been used by the broadcast industry for many years. In the center are data obtained from General Electric on the Z5294 tube, incorporating the silver bismuth (S-10) photocathode and the MgO target. On the left are data obtained and furnished by RCA on its experimental tube C74036 which incorporates all the features previously mentioned.

It should be noted that the Z5294 is also available with a tri-alkaline photocathode. This type of tube may be readily coupled to an image-intensifier, or image-converter tube, by use of either conventional optics or highly efficient fiber optics.

Also shown on the right hand side of Fig. 2 is the relative speed of Royal X Pan Film developed to 1600 ASA. A 0.2-sec exposure time was used to show comparison with television on an equal basis, since the television data were made with eye observation and the eye has an integration time of approximately 0.2 sec.

Figure 2 shows that there is a region below 10^{-3} ft-c (foot-candles) in which television has a definite useful advantage. Above 10^{-2} ft-c the resolution capability of film increases rapidly and there is no question that film is better. Another very important observation may be made from these curves. The resolution vs. light-level characteristic for film is very steep but that for the 5820 and Z5294 is slanted considerably and that for the C74036 is quite flat. This is significant in that there is a narrow region of photographic exposures below which a picture cannot be obtained. Above this critical level of exposure, film resolution far exceeds that of television. Below this critical exposure, however, and for many orders of magnitude of decreasing exposure, television is still usable, though of lesser image quality.

The nomogram on the lower half of Fig. 2 is for the convenience of those who are more familiar with scene illumination and lens aperture than with foot-candles on the sensitive surface. The two examples demonstrate that some information may be obtained on a cloudy, moonless night, using the C74036 tube, whereas film would require light levels existing only during daylight and twilight. This is a factor of 10,000.

Figure 3 shows a series of photographs of a high-quality aerial photograph. The sequence, of decreasing exposure values, demonstrates how rapidly direct photographic quality falls to practically "no exposure." Figure 4 shows an equivalent sequence of photographs through a television camera. The quality of the television picture falls off comparatively slowly.

Image Storage

The television sensitivity data shown in Fig. 2 were taken at a standard frame rate of 30 frames/sec. The MgO target is capable of considerably longer storage periods. Storage of the image on the target for several seconds is possible with only a small degradation of image quality, and even longer periods have been reported. Thus, this technique is available as a means of varying "exposure" to obtain increased sensitivity. It is useful in those applications where sensitivity at 30 frames/sec is inadequate and where motion of the image does not prohibit the longer exposure interval. The sensitivity increase will not, however, increase linearly with time as in the case of film. It increases closer to the square root of the ratio of exposure times. Actually, the signal will increase linearly, but the noise in the reading beam will also increase, tending to hold down the effective sensitivity gain.

An easy method of accomplishing an increase in storage time is to switch the reading beam off, in the pickup tube, in such a manner that the target is allowed to accumulate charge for a number of frames. The beam can then be pulsed on for one frame, and the target charge read out during this interval. If a kinescope recording camera is used, it would then have to be synchronized with the television readout.

Effective Exposure Time

An image orthicon operated at fairly high levels of illumination has an effective exposure time equal to the field time, or 1/60 sec for 30 frames/sec 2:1 interlace scanning. Its motion-stopping ability, or effective shutter speed, is equivalent to a film camera shuttered at 1/60 sec. At low levels of illumination, this effective exposure time is longer and may exceed 1/30 sec, owing to the time required to build up charge on the target.

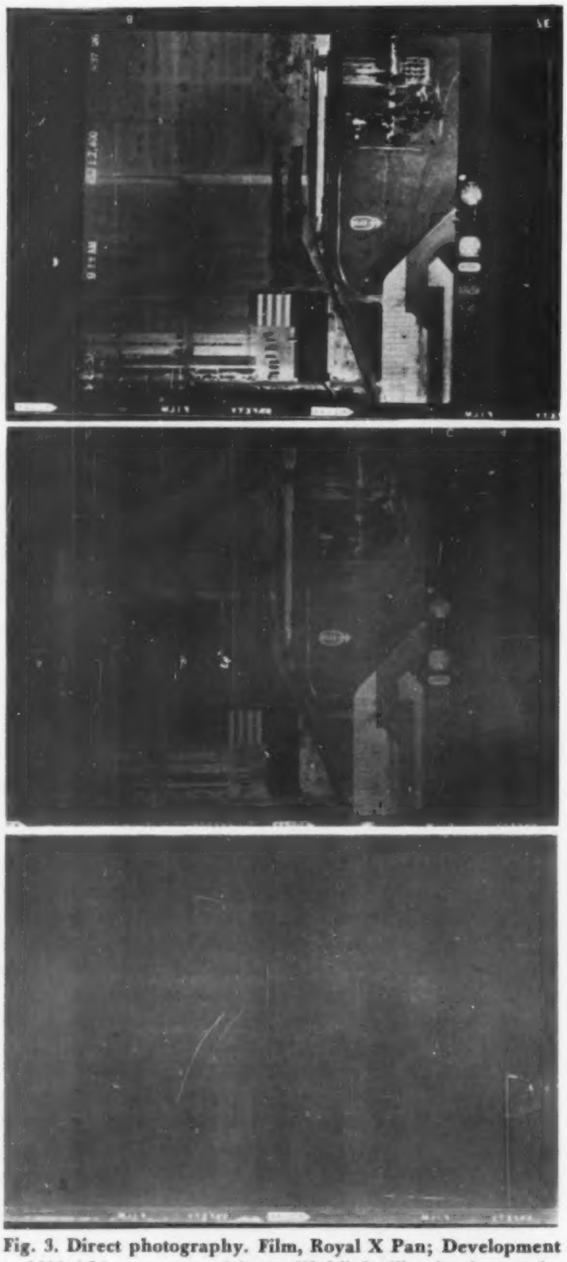

Fig. 3. Direct photography. Film, Royal X Pan; Development to 1600 ASA; exposure, 0.2-sec. Highlight illumination at the film: (top) 7×10^{-3} ft-c; (center) $2 \times 10^{-}$; (bottom) 3×10^{-3} ft-c.

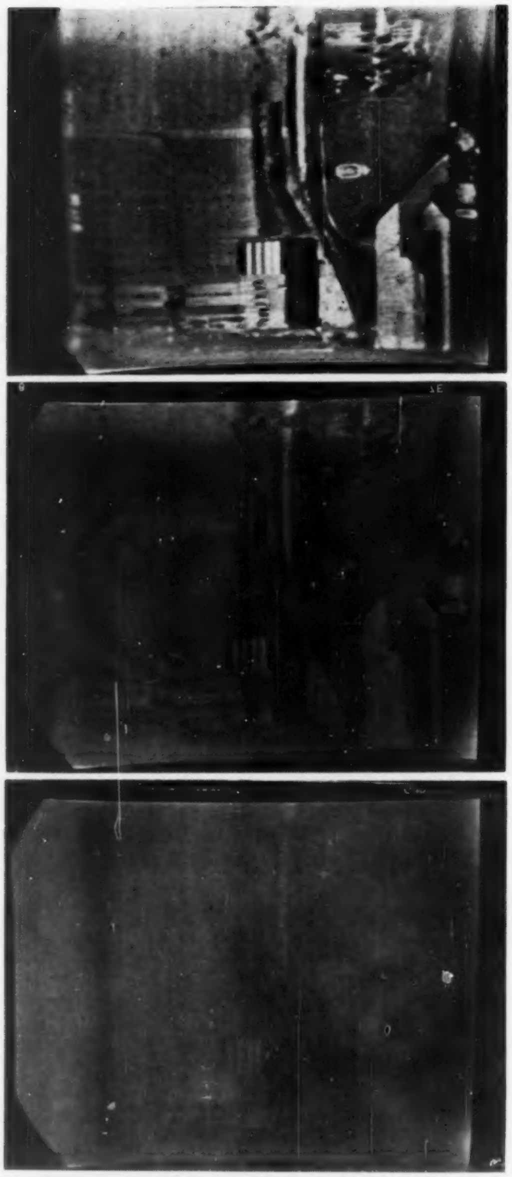

Fig. 4. Kinescope photograph. Tube, Z5294; 30 frames/sec; exposure of film, 0.2-sec. Highlight illumination at the photocathode: (top) 10^{-4} ft-c; (center) 2×10^{-5} ft-c; (bottom) 5×10^{-6} ft-c.

The image orthicon also displays another characteristic which is important when viewing motion. Because of the target capacitance and beam resistance, a single pass of the beam over the target does not fully discharge the target. Therefore, information remaining on the target will be superimposed on later frames. This gives the effect of image persistence. The degree of this persistence is related to light level and the effect is most severe at low light levels. Twenty-five per cent of the target charge may still be present following 2 or 3 frames at high light levels, and this may extend to 6 or 8 frames at low light levels.

The effective exposure time is therefore dependent on the build-up and discharge intervals. It is not single valued and may be estimated for various purposes, as follows:

1/60 sec — shutter speed — high illumination
1/30 sec — shutter speed — low illumination
1/15 sec — image persistence — high illumination
1/4 sec — image persistence — low illumination
1/5 sec — effective integration period when viewed with the eye.

Theoretical Limitations

The light in an image contains a multitude of individual photons. As the light level is reduced to the region of 10^{-8} to 10^{-9} ft-c, the quantity of protons received per integration period is small and they arrive with a ran-

dom distribution in time. This randomness creates noise which Rose[1,2] has shown is equal to the square root of the number of photons. By including other factors, such as the eye integration period and minimum signal-to-noise ratio for detection, it is possible to draw curves which show the relationship between limiting resolution and light level.

Curves which show statistical limitations as usually computed are in conflict with the published data on the C74036 tube. The tube data indicate resolution at light levels below those which would normally be expected from the statistical noise limitation. The error is probably one of application of Rose's theory. It appears that further work is required to better define the minimum detectable signal-to-noise ratio, the eye integration period and the relationship between small-area resolution and line resolution.

One important observation that should be realized from the apparent conflict of theoretical and experimental data is that tubes are now being made which are extremely close to, if not already at, the statistical photon noise limit.

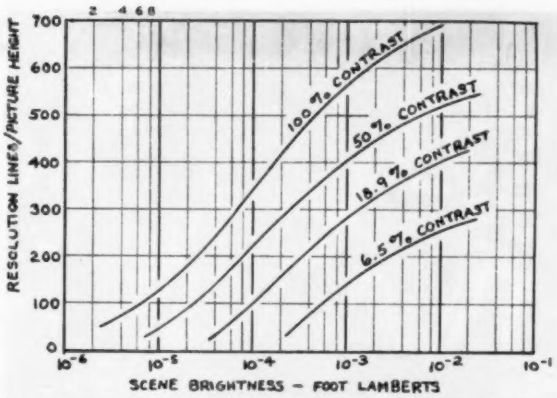

Fig. 5. Image orthicon sensitivity: image orthicon, Z5294; S-10 photocathode; 30 frames/sec; $f/1.5$ optics.

Sensitivity Ratings

Sensitivity is specified in terms of the light level required to produce a picture of a given "quality." Several factors are involved in determining picture quality, and the most controversial of these is the method of specifying resolution.

Limiting resolution, as used in this paper, has been shown to be inadequate, though it is a common means of specification in the fields of television, photography and optics. Limiting resolution will probably continue to be used because of the simplicity and convenience of understanding, applying and measuring it. A complete sine-wave aperture response curve is needed to specify completely the resolution capabilities of an imaging device. These measurements are difficult to make, and unfortunately this type of data is not available for the various tubes discussed in this paper.

One way in which the value of resolution data can be improved considerably is to include the contrast of the image as another variable. Figure 5 shows a typical set of data taken on a Z5294 tube. By knowing the contrast values in the scene, or in portions of particular interest, a better appreciation may be obtained of the overall quality of the picture. This is particularly important where the picture content is predominately of low contrast. In this case, the usual high-contrast resolution data may be misleading.

ASA ratings have also been suggested by Neuhauser[3] as a means of rating the sensitivity of television pickup tubes. He shows that the 5820 tube has an ASA exposure index of 16,000 when the tube is exposed with the highlights at 0.01 ft-c. On a similar basis, it would be possible to rate the Z5294 tube with an exposure index of approximately 160,000. A rating for the C74036 would be difficult to estimate on the same basis.

An entirely different set of ASA rating numbers could be selected for different resolution levels. The ASA rating specification requires the selection of an exposure value, or light level, which cannot be uniquely defined for television. There is a significant difference in slope of the resolution curves, as pointed out earlier in connection with Fig. 2. The C74036 tube increases rapidly in sensitivity as the resolution requirements are reduced; much more so than the Z5294 or the 5820. Therefore, ASA ratings have little meaning for television pickup tubes unless they are accompanied with a specification of light level or resolution level.

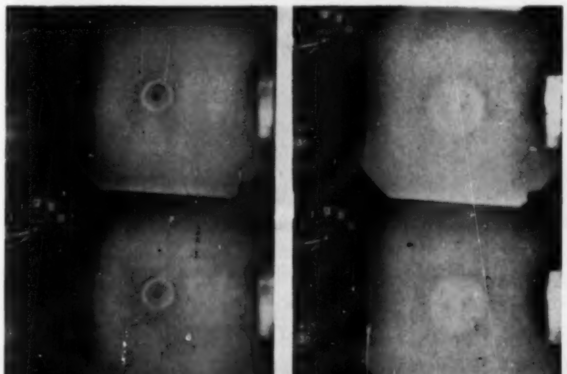

Fig. 6. High-altitude chemical release photographs: left, 2 sec after burst; right, 6 sec after burst.

Fig. 7. Television cameras for data recording of missile trails.

Application

During 1959 the Bendix Corp., Friez Instrument Div., operated an instrumentation facility for the Air Force Cambridge Research Center to record high-altitude shock waves emanating from predawn upper-atmosphere chemical releases. A Bendix television camera was directed at the burst and film recordings were made from the monitor with a 16mm camera. Photographic excerpts from one of these shots are shown in Fig. 6. These pictures show the expansion of the shock wave. On the left hand side of each frame is a data chamber, and on the right hand side is a calibrated gray scale that had been inserted directly on the face of the Z5294 image orthicon. This wedge and a knowledge of the optics were used for estimating the object brightness. The photographs were taken at 15 frames/sec.

During 1960 Bendix Friez designed and operated more elaborate television equipment, shown in Fig. 7, for the Atlantic Missile Range. The purpose of this installation was to obtain pictures of missile trails, and to obtain a spectral analysis of the low-intensity light in these trails.

The television camera on the lefthand side of Fig. 7 was equipped with a $7\frac{1}{2}$-in. focal length $f/2.5$ lens and a Z5294 image orthicon. The camera on the righthand side was equipped with a three-lens spectrometer of conventional design and an experimental C74036 image-intensifier orthicon. The equipment obtained useful data which could not have been obtained by direct photography.

Other applications of high-sensitivity television as an aid to photography would include underwater photography, satellite tracking, nuclear particle tracking, x-ray image recording and spectrum analysis.

Future Improvements

Some of the recent improvements in television camera tubes have been mentioned in this paper. The quality, sensitivity and versatility of pickup tubes is improving at a rapid rate. A major emphasis is being placed on improving resolution at low light levels and at low values of contrast. Improved storage capability is also being sought, and reduced beam noise may be a reality in the near future. These improvements, combined, will amount to a major breakthrough in low-light-level photography and data recording.

Acknowledgments: I wish to express my appreciation to Norman W. Rosenberg and William Hamilton of the Air Force Cambridge Research Center for their encouragement in this work and to J. L. Hessenauer of Bendix Friez in helping to prepare this paper.

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An $f/1$ Streak Camera for Spark Studies in Both Ultraviolet and Visible

By J. DYSON, R. F. HEMMINGS and R. T. WATERS

A rotating-mirror streak camera with 0.015 in./μsec writing speed, f/1 aperture and spherical reflection optics (save for a fused-quartz window) has been constructed. The camera, which is equally useful in the ultraviolet and visible light ranges, has a rotating mirror driven by a 1500-rps electric motor. A technique for molding film to the required spherical focal surface has been developed.

The camera is used to study the electrical breakdown development rate and structure of 2-m air gaps by high-voltage discharges, particularly the very high-speed low-luminosity processes which precede the final brilliant arc phase. This last arc phase must be suppressed in order to avoid severe fogging of the record. Techniques are described for superimposing reference points on the image to define time axis, gap axis, spark position in space and writing speed. Photographs show the appearance of the filamentary corona, the growth of the glow discharge at velocities exceeding 10^8 cm/sec and the discontinuous stepped progress of the spark leader.

1. Introduction

The breakdown of a long air gap by a high-voltage surge produces a brilliant flash within a time of the order of 10^{-5} sec. This high luminosity is due entirely to the high energy input during the arc phase following the establishment of the discharge path. The early work of Allibone and Schonland[1] and Allibone and Meek[2] with moving-film cameras showed that the luminosity during progress to breakdown was low, arising mainly from leader plasma channels propagating across the gap (in analogy with the lightning mechanism).

Although this filamentary structure constitutes an ideal subject for streak photography, difficulties are caused by the requirements of high time resolution, high aperture and the necessity to record the ultraviolet region of the spectrum, where much of the radiation from the discharge lies. In addition, the arc phase of the discharge causes severe fogging of records unless suppressed.

The inclusion of a series resistance in the discharge circuit alleviates this last difficulty and simplifies examination of the breakdown by retarding the rate of propagation. However, it was desired to avoid a series resistance in the present work since its effect is to reduce the gap potential difference in an uncontrolled way throughout the breakdown process. Instead, the arc was prevented by rapid removal of the gap voltage at about 10^{-7} sec before complete breakdown by means of a parallel gap system. Similar methods have been used previously in conjunction with still photography,[3,4] but the parallel gap used here was automatically triggered by the discharge growth.

The increasing discharge current was used to generate a voltage across a nearby coil; this was used to fire a trigatron system in order to ground one sphere of the chopping gap. This sphere was originally held at 20% of the impulse-generator output voltage, the opposing sphere being at the full voltage. Since the sphere gap was arranged just to withstand 80% of the output voltage, the grounding of the first sphere resulted in rapid breakdown of the gap and quenching of the discharge under study. The adoption of this procedure increased the importance of the above requirements.

In this paper a rotating-mirror camera is described; the technique of analyzing the photographs and some experimental results are given.

2. The Streak Camera

The Optical System

In addition to the essentials of high-speed and good ultraviolet transmission, it was necessary that the camera objective should have a considerable rear working distance in order to accommodate the rotating mirror. It was felt that these requirements could best be satisfied by a monocentric pair of spherical mirrors as shown in Fig. 1. The chief disadvantage of this system is its large size for a given focal length and aperture, but no other systems which were investigated met the above demands with adequate field and image quality. The cost of the system is not excessive, however, because the optical quality of the large mirror need not be very high in view of the finite resolving power of the fast films used.

As there are only two curved optical surfaces, which have a common center of curvature, it is necessary to pay attention only to the elimination of spherical aberration. Off-axis aberrations, such as coma and astigmatism,

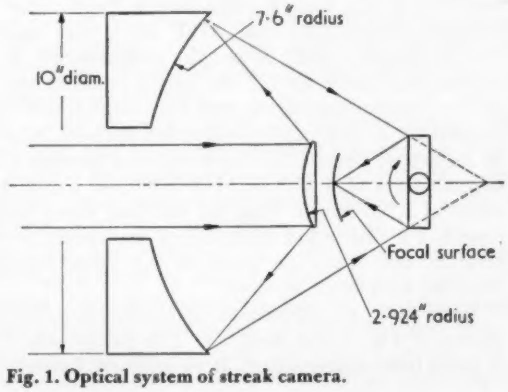

Fig. 1. Optical system of streak camera.

Presented on October 20, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D. C., by K. R. Coleman for the authors, J. Dyson R. F. Hemmings and R. T. Waters, Associated Electrical Industries Ltd., Aldermaston, Berks, England.

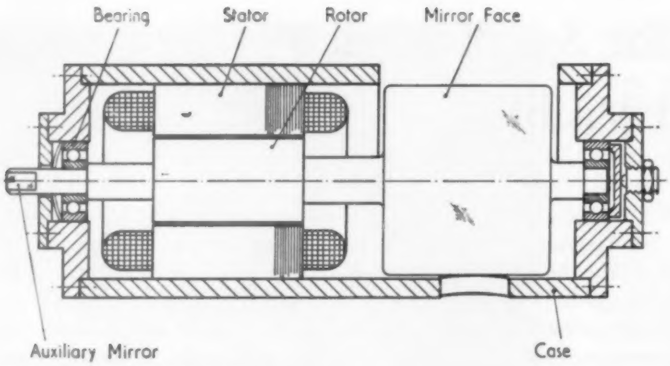

Fig. 2. High-speed mirror unit.

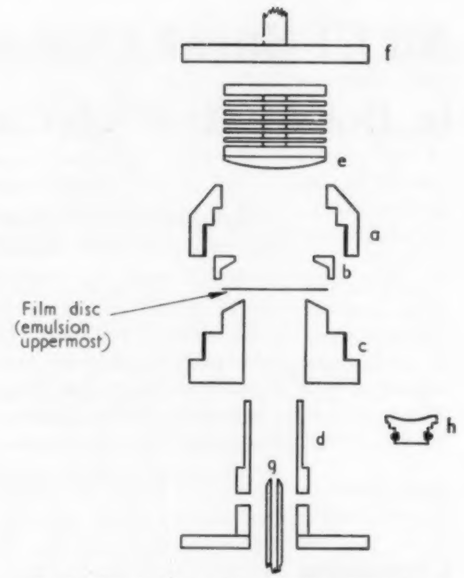

Fig. 3. Film molding and mounting apparatus.

do not arise, as there is no optical axis and the optical conditions (except for vignetting) are identical in all parts of the field. It was found possible to attain an aperture of $f/1$ with a resolving power of at least 50 lines/mm.

The focal length was limited by the dimensions of the rotating mirror and was designed to be 2.4 in. By suitably positioning the axis of the rotating mirror, the required film surface was made spherical, rather than toroidal, thereby avoiding difficulties in manufacture. As the rotating mirror has appreciable thickness, the image surface tilts somewhat with respect to the film surface at the ends of the scan, so only a central strip of the image, parallel with the axis of rotation, remains strictly in focus. However, the effect is small, and for objects of the general shape of the discharges considered, the depth of focus of the system is not exceeded. In the case of the multislit technique described later, trouble due to this cause is avoided because of the necessarily small amplitude of scan.

The ultraviolet transmission is limited ultimately only by absorption in the fused-quartz vacuum window. Reflection from the three aluminized mirror surfaces can be expected to be good down to wavelengths approaching 2000 A provided that their age is not too great.

The Rotating Mirror

Two similar mirror units were designed, one for use in the $f/1$ camera, the other in a more conventional camera also requiring a large mirror area. The mirror was required to run intermittently, and for the drive it was decided to use high-speed induction-motor components of the type WKT 1108 manufactured by A.E.I. (Rugby) Ltd. The motor was supplied from a three-phase high-frequency alternator type AHT 2615, also made by A.E.I. (Rugby) Ltd. A simple paddle-wheel type of mirror was chosen so that the axis of rotation was close to the plane of the mirror and the image could thus be focused on a very nearly cylindrical surface. According to the simple formula for the stress on a laminar rotor, a chrome steel of a U.T.S. of 200,000 psi would give a value of 3,700 in. sec^{-1} for the product, speed times the radius. The dimension of the mirror was chosen from this product and from the speed of the induction motor, allowing for a factor of safety.

With these considerations in mind, the mirror unit shown in Fig. 2 was designed. The paddle-wheel rotor is made from stainless steel, stress relieved, hardened and tempered to give a U.T.S. of 240,000 psi. At one end, the mirror, integral with the shaft, gives a polished reflecting surface 2¼-in. long and 2¾-in. wide.

The mirror surface was ground, optically polished and aluminized. No protective layer was used as maximum reflectivity in the ultraviolet was required.

At the other end, the rotor of the induction motor is a press fit on the shaft, and a small mirror is provided to give triggering pulses from an auxiliary light beam and photocells both for triggering the impulse generator to obtain synchronism and for tachometry. Double-sealed ball races are fitted to each end of the shaft and are located in the end plates of the Dural housing. This type of bearing was used to prevent lubricant from marking the mirror surface, and in view of the intermittent duty required, the limited life of the bearing was not considered a serious disadvantage.

The high-speed electric motor was made up of a standard stator and rotor, the maximum speed recommended by the makers being 60,000 rpm. To achieve this speed, a rough vacuum was required to reduce the windage of the rotor. Again in view of the low-duty cycle, no special provision was made for cooling the rotor, which was located inside the housing by means of screws. The motor was supplied from a three-phase high-frequency alternator, 76/229 v, 0.87/2.62 amp, 500/1500 cps, which was belt-driven from a 1.5-hp d-c motor. The field current was fixed and the armature supply voltage was varied to give the required range of speeds. It was ensured that the preset frequency could not be exceeded.

With this design the calculated ultimate speed of the rotor is 166,000 rpm, so that at 60,000 rpm the safety factor on the stress in the chrome steel is 7.5. Nevertheless an overspeed test was applied to both mirror units. They were set up with their axes horizontal inside a vacuum-tight steel base which was itself housed in a splinter-proof chamber. Deflection of the mirror due to bending of the shaft was measured by a light beam reflected from the mirror face on to a scale 10 ft away, and mirror speeds were measured from the audible beat rate

between the mirror speed and the synchronous frequency. The first unit was run at 71,000 rpm for 10 sec, in the course of which time the bearings ran warm and were damaged. The second was run at 63,000 rpm for 10 sec without trouble. A slight, very broad critical response occurred at some 30,000 rpm, corresponding to a deflection of the mirror surface from the axis of 1 in 3,200.

As a result of the tests it was decided that the units would be quite safe if run at 40,000 rpm and if necessary retested to run at 50,000 rpm. The time taken to reach 50,000 rpm was about one minute with a constant supply frequency.

In the present camera the mirror has been used for runs under reduced pressure at speeds up to 30,000 rpm without trouble. At atmospheric pressure, windage losses limit the speed to 15,000 rpm.

Camera Assembly

The optical components and rotating mirror were housed in an aluminum vacuum chamber of $\frac{7}{16}$-in. wall thickness, which was rigidly mounted on an adjustable stand. A plane quartz window of $\frac{1}{2}$-in. thickness provided a 5-in. diameter ultraviolet-transparent aperture for the lens.

Access to the chamber was allowed by two doors, which were sealed by rubber O-rings when closed. A rotary vacuum pump evacuated the chamber to approximately 1 psi, the pressure being controlled by a needle valve.

The steel mounts for the photographic film were fitted with spring ball catches which were designed to give easy attachment to the camera while eliminating any risk of incorrect location.

The camera was focused by rotation of the threaded barrel of the concave mirror housing.

Film Molding and Mounting

The large curvature of the concave focal surface necessitated the development of a procedure for molding and mounting high-speed photographic film to coincide with this surface to ± 0.0005 in. The chordal diameter required was 1.25 in. and the radius of curvature was 2.4 in. It had already been shown possible by other workers[6] to produce such distortion for convex focal surfaces by heating the acetate film base while cooling the emulsion.

The apparatus devised in the present work is shown in Fig. 3. The 2.25-in. diameter film disc is rigidly mounted in the jig a, b, c before molding. The assembled jig is placed on the shoulder of the barrel d, and the film is stretched to the correct curvature while cold by the polished surface e and the press f. Warm air from the nozzle g heats the film base to approximately 50 C for 10 min. The copper bar and cooling vanes welded to the stainless-steel molding suface maintain the emulsion some 20 C cooler. A 10-min cycle of unheated air completes the molding operation.

For exposure in the camera the film is attached to a mount of the correct curvature. Since the camera chamber is evacuated, suction mounting[5] is not possible. The adhesive requirements are stringent, viz., quick setting and good adhesion to metal and the acetate base, while allowing easy separation after exposure and removal of traces from the film. A 20% solution of pure gelatine in water is found suitable. This concentration has a melting point of about 30 C. A small amount of glycerol is added to reduce viscosity. The adhesive power is adequate provided that about 1-psi air pressure remains in the camera chamber during operation, and that film storage of more than a few days is not required. The mounting is carried out in the same molding apparatus. The jig is removed following the cooling cycle, the mount h plus adhesive is placed on the lip of the barrel d and the unit is reassembled. Adhesion is complete within 10 min.

Six machines are connected to the air line to enable the preparation of 12 discs/hr. No marking, fogging or loss of speed of the emulsion is experienced. It is found, however, that an extended development time is necessary owing to a slight hardening of the emulsion surface.

The molding procedure produces only slight permanent distortion in the film. Following removal from the holder and processing, the discs are mounted between plane glass. Image measurement is greatly facilitated by the fact that, for uniform elasticity of the film, the distortion of the image upon contraction is such as very nearly to counteract the original dimensional distortion due to the spherical focal surface.

3. Analytical Procedures

Previous workers have estimated lightning and long spark leader velocities by measuring time displacements relative to the high velocity return or arc stroke path (it has been shown in this Laboratory that the arc velocity exceeds 7.5×10^9 cm/sec). Although an incomplete arc phase was strongly recorded in the present experiments (see Sec. 4), its contour was too ill-defined for precise work. Stationary records of the breakdown track were therefore obtained by a pair of low-aperture glass-lens cameras, equidistant with the streak camera from the discharge gap, one providing a co-axial but opposite viewpoint and the other being at right angles to this axis.

Prior to experiment a plumb line was placed in the gap and photographed by all three cameras. The image of small mirrors reflecting the light from a switching gap of the high-voltage generator appeared both on the plumb-line records and on the spark records. The axis of the discharge gap could thus be defined on all spark photographs. A further advantage of this technique was that the intensity of the switching gap discharge was at maximum both at the instant of firing (time zero) and at the time of voltage suppression. Thus pairs of light markers appeared on each streak record, accurately defining these times and the time axis itself.

Measurements were carried out by a traveling microscope on the negatives and from enlarged prints. As stated earlier, the dimensional distortion on the streak record was negligible, e.g., the plumb-line images were straight lines, which retained parallelism for various rotating-mirror positions.

In a long spark discharge the track frequently deviates some tens of centimeters from the gap axis. Since the cameras recorded perspective effects and not simple elevation views, suitable corrections had to be made to both vertical and horizontal apparent coordinates.

Accurate measurements of the three-dimensional track lengths could be made by these means; since with optimum image quality the contour of the track could be measured to approximately ± 0.0004 in., it would be possible to measure time intervals of 10^{-8} sec along the spark track at a mirror speed of 1000 rps. Film distor-

Fig. 4. Positive impulse corona in a rod-plane gap at 430 kv.

Fig. 5. Streak record of suppressed 1-Mv positive impulse breakdown in a 2-m rod-plane gap (f/1 camera).

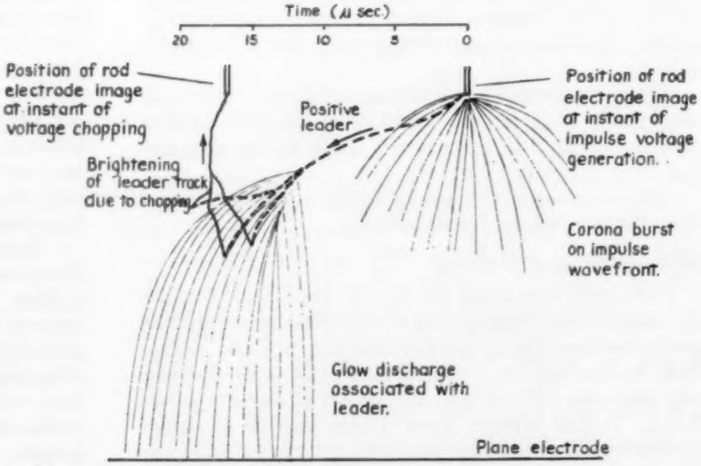

Fig. 6. Diagrammatic representation of Fig. 5.

Fig. 7. A discharge similar to that in Fig. 5, time-resolved with an f/2.5 glass lens.

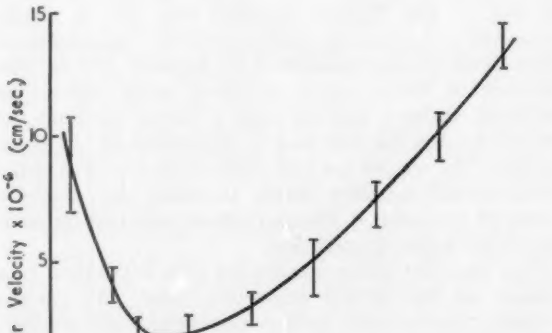

Fig. 8. Mean leader velocity in 1-Mv impulse breakdown of a 2-m rod-plane gap.

tion, however, reduces this precision for long time intervals and for events widely differing in spatial position.

An alternative recording technique similar to that of Komelkov[4] was also used: the streak-camera time axis was arranged parallel to the vertical gap axis, a screen with five horizontal slits being interposed between the gap and camera. Time analysis was considerably simplified, the method being valuable for examining the diffuse regions of the discharge.

4. Experimental Results

Examination has been made of the breakdown, under 0.25 to 2000 μsec positive-polarity impulse voltages up to 1-Mv crest, of a 2-m rod-plane gap and a 1.7-m rod-rod gap.

The camera is found to strongly record features barely visible to the eye. The corona discharge shown in the stationary record of Fig. 4 is typical of the partial breakdown near a high-tension anode very early on the impulse wave. Visual observation reveals merely a small glow near the anode surface.

Figure 5 shows a streak record of a suppressed discharge in a point-plane gap. This photograph is explained diagrammatically in Fig. 6. For comparison, a similar record obtained with an $f/2.5$ glass lens is shown in Fig. 7. Figure 5 records the leader even in the early low-luminosity stages.

The mean velocity of the leader obtained from six such records is plotted in Figure 8. The minimum in the curve indicates a critical stage in the leader development at which its capability to traverse the gap is determined.

The structure of the leader stroke is clearly shown in Figure 5. The leader luminosity is not continuous along its length, as previously believed, but consists of a series of steps. This appears closely analogous to the stepped structure of the lightning first-leader channel described by Schonland. The mean step length on this record is 1.2 cm and the channel radius is approximately 0.2 cm. Since Schonland's quantitative model[7] for a stepped leader propagating in a field of 3 kv/cm predicts a ratio of 6 for step length/radius, the present data are in excellent agreement with the theory despite the difference in scale.

Figures 5 and 7 also show that upon removal of the applied voltage, the whole leader track undergoes a large increase in luminosity. This luminosity exhibits no discontinuities; thus to a visual observer or a stationary camera the true leader structure is not apparent.

A diffuse glow discharge accompanying the filamentary growth is recorded. Its contour follows the electric lines of force. It is best examined by the slit technique already described, an example of which is given in Fig. 9. This shows that although much of its luminosity is emitted when suppression takes place, a glow does propagate across the gap ahead of the leader channel. Its initial velocity is approximately 4×10^6 cm/sec, increasing to a final velocity exceeding 10^8 cm/sec.

These records also reveal a delay of about 10^{-6} sec between the filamentary corona at the high-tension

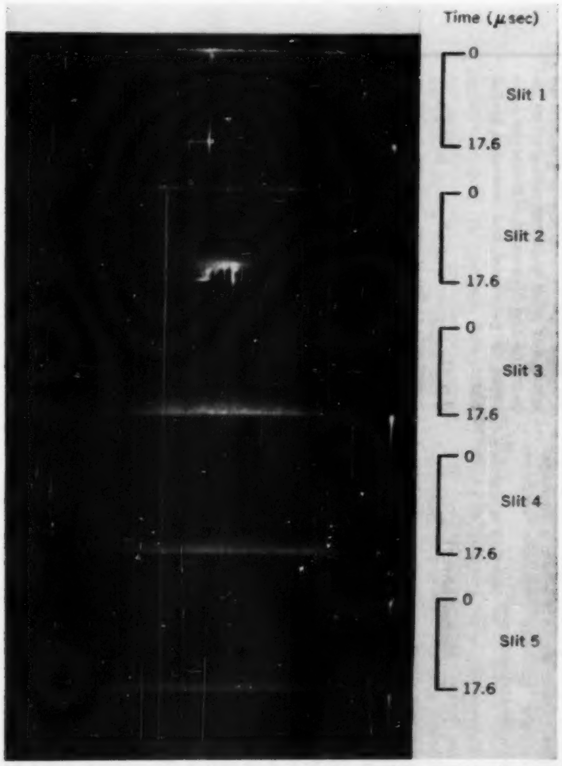

Fig. 9. A discharge similar to that in Fig. 5, time-resolved using the slit method.

Fig. 10. Streak record of suppressed 970-kv positive impulse breakdown in a 170-cm rod-rod gap.

anode and the appearance of the leader. In the interval the anode is surrounded by a uniform glow. It is also clear that each point of the leader track maintains luminosity throughout its growth, brightening and broadening with increasing overall length.

Figure 10 is a streak record of a discharge in a rod-rod gap. The general structure is similar to that of the rod-plane gap, but here there is also a negative leader from the grounded rod. The anode leader is found always to precede the cathode leader.

5. Acknowledgments

The authors wish to express their gratitude to T. E. Allibone, Director of the Laboratory, who initiated this experimental investigation of the spark discharge, for permission to publish this paper; to K. R. Coleman and A. E. Huston, Atomic Weapons Research Establishment, Aldermaston, for polishing and testing the rotating mirror; to the staff of Associated Electrical Industries (Rugby), Motor Engineering Dept. for supplying the high-speed electric motor; to C. Waller, Ilford Research Laboratory, for help with photographic materials; to the staff of this Laboratory for design and development work on the mirror unit; to D. P. R. Petrie for useful discussions; and to R. E. Jones for his help in the experimental work.

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Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

standards and recommended practices

Approved American Standard

A new American Standard, PH22.124-1961, Screen Luminance for Indoor Theaters, was approved by the American Standards Association on May 5, 1961. This Standard is substantially as published in the April 1960 Journal. A copy of the Standard is available from the American Standards Association, Incorporated, 10 East 40th Street, New York 16, at a nominal cost.—*Alex E. Alden*, Staff Engineer

American Standard

Screen Luminance for Indoor Theaters

ASA Reg. U.S. Pat. Off.

PH22.124-1961

*UDC 778.2:725.824

Page 1 of 3 Pages

1. Scope

1.1 This standard specifies the luminance (brightness) of the projection screen—whether perfectly diffusing or directional—for indoor theaters equipped to project 35mm motion-picture film at a rate of 24 frames per second.

1.2 This standard specifies screen luminance levels at which the tone scale, contrast and pictorial quality of the projected image from release prints will be of the quality anticipated during their production, and is intended to provide for such quality throughout the audience area.

1.3 This standard describes criteria for evaluating the suitability of a screen — whether perfectly diffusing or directional — for a particular theater by establishing a luminance level and maximum luminance variations within the audience area.

2. Measurement

2.1 The measurement of screen luminance is made with the projector in complete operation but with no film in the aperture.

2.2 Screen luminance shall be measured with a photometer having the spectral sensitivity of a standard observer as specified by the International Commission on Illumination in 1931. The acceptance angle of the photometer shall be as small as is practical, and shall be so used that it accepts light from a screen area no larger than a circle whose diameter is 10 percent of the screen width.

3. Luminance Level

3.1 The luminance at the center of the screen shall be 16^{+4}_{-6} ft-L (55^{+14}_{-21} nits) as measured from a position on the longitudinal centerline of the auditorium and two thirds distance from the screen to the rearmost row of seats.

3.2 The luminance at a distance 5 percent of the screen width from the side edges of the screen, and on its horizontal axis, shall be between 65 and 85 percent of the center luminance as prescribed and measured in 3.1 above.

3.3 The luminance at all points on the horizontal axis of the screen, between points located at a distance 5 percent of the screen width from the sides of the screen, shall be between 5.5 and 20.0 ft-L (19 and 60 nits) and of no greater range than 3:1, as measured from any seat in the auditorium.

Approved May 5, 1961, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

Printed in U.S.A. ASA%M961/46

APPENDIX

(This Appendix is not a part of American Standard Screen Luminance for Indoor Theatres, PH22.124-1961, but is included to facilitate its use.)

A1. *Standard Luminance.* Possible luminance levels are limited by a minimum value below which the visual process becomes less efficient, and by a maximum value above which flicker becomes objectionable. Permissible luminance range is limited by the criterion that a good release print must provide acceptable quality when projected at any luminance within the range.

A2. *Other Variables.* In addition to the luminance distribution, the pictorial quality of projected pictures is influenced by the color of the projection light, the color and characteristics of the screen surface, the presence of stray light, the nature of the surround, and other factors not presently described by standards.

A3. *Preferred Screen Luminance.* This is considered to be that condition wherein (1) the luminance of the center of the screen is constant from every usable seat in the theater and is within the limits of 14–16 ft-L; (2) the luminance of the sides of the screen is approximately 85 percent of the luminance of the center; and (3) the luminance variation has axial symmetry around the center of the screen. The nominal value in 3.1 has been chosen to represent such preferred luminance. The tolerances have been selected to include viewing conditions which experience has shown to be acceptable and to exclude those known to be undesirable. As screen design permits more optimum control of luminance gain, it is expected that tolerances will be reduced and will become more symmetrical.

A4. *Indoor Theaters.* This standard is limited in scope to indoor theaters because it has been observed that optimum screen luminance for projected pictures depends upon the conditions of viewing. Under the conditions of the indoor theater with the screen subtending a large angle at the observer's position, with low stray-light levels, etc., these conditions have been found by experiment and experience to represent the best compromise among the many factors involved, but not necessarily the best situation for drive-in theaters and for auditoriums with high ambient light.

A5. *Directional Screens.* Matte white screens will show substantially constant luminance at any one specific area on the screen for measurements from any location within the theater. Directional screens in current use have been designed to produce specific reflection patterns which on goniometric measurements of luminance from various viewing angles show wide departures from the properties of a perfectly diffusing surface. By suitable choice of such patterns the attainable luminance may be increased considerably above that possible with a perfectly diffusing screen of the same size when measured near the axis of projection, although there may be a significant variation in luminance with viewing position in the theater.

A maximum permissible variation is given in 3.3; in a particular theater this condition can be met by several procedures, including one or more of the following: choice of a screen with a suitable reflection pattern; limitation of the seating area so that no patron views the picture from an angle at which the luminance is outside the tolerance of the standard; and curvature of the screen. (In practice the curvature of screens whose surface is continuous is limited to a radius equal to or somewhat greater than the projection throw to avoid excessive re-reflection and contrast loss.)

A6. *"Luminance gain"* is defined as the ratio of the luminance of a specified area of the screen to the luminance of a perfectly diffusing and perfectly reflecting surface, both measured under the same conditions of illumination and observation. For directional screens, luminance gain is a function both of the direction of illumination and of the direction of observation. With any given screen these two vectors may be chosen so that the luminance level obtainable is made a maximum, and this condition defines the "maximum luminance gain."

A7. *Limitation on Luminance Range.* Present directional screens show a large variation in gain with changes in the projection and viewing angles, necessitating the 3:1 luminance ranges prescribed in 3.3 when the more desirable screens are fitted into existing theaters. Even this range effectively limits the maximum luminance gain of the screen, and the wider the theater becomes, the lower the maximum luminance gain must be to meet luminance specifications with most existing directional screens. When screen design permits a smaller luminance range, it is intended that this standard be revised accordingly.

A8. *Maximum Screen Size.* Projection light output and screen luminance gain together determine the maximum screen size that can be illuminated to produce standard luminance.

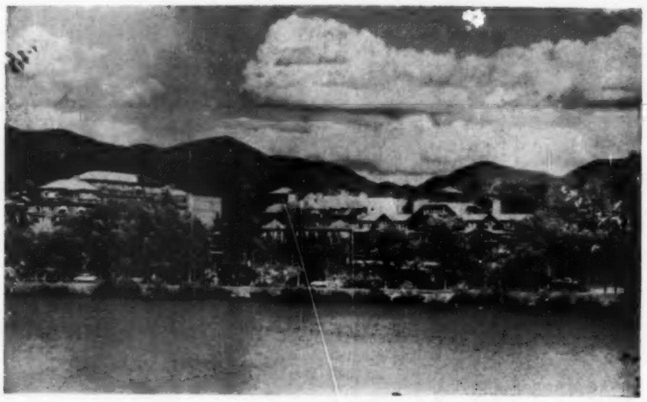
A9. *Meter Acceptance Angle.* The maximum permissible acceptance angle of the luminance photometer will depend upon the instrument design and method of use, the size of the screen and other factors. The acceptance angle of a suitable instrument must be such that a reduction in this angle (followed by necessary recalibration) does not change the magnitude of any reading specified in 2 by more than ± 5 percent. The limiting conditions for the reliable use of such meters should be included in the manufacturer's specifications.

A10. *Conversion of Units.* Screen luminance in the U.S. is customarily measured in foot-Lamberts, although in international usage the nit is the preferred unit. 1 nit = 0.2919 ft-L; 1 ft-L = 3.426 nits.

A11. *Image Luminance.* Note that this standard specifies screen luminance with no film in the projector aperture. When films are projected, the average image luminance will be considerably below this level.

90th Semiannual Convention

October 1-6
Lake Placid Club, Essex County, N.Y.



Theme: Integration of Motion-Picture and Electronic Systems

"All work and no play," as the old saying puts it, is a rather dull state of affairs — fortunately at Lake Placid there will be plenty of play to balance the work of the 90th Convention.

An excellent program of technical and scientific papers, many of trend-setting significance, has been developed by Program Chairman C. Loren Graham and ten special topic chairmen, working under the Society's Papers Committee. The listing of this Committee in the April *Journal* and the occasional announcements, however complete, such as in the May *Journal*, are no indication of the extensive and assiduous efforts contributed to make a papers program. Then, to put on the show: only those who have done it know either the overall or the very particular pieces of planning and arranging required.

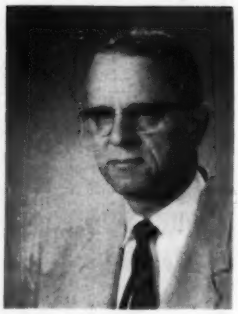
Local Arrangements Chairman Eric C. Johnson and Vice-Chairman Arthur J. Miller have had the overall responsibility for the wide range of planning the activities and services that make an effective Convention week. Besides providing the services of a forum for speakers, there is the very important entertainment program. At Lake Placid there will be a golf tournament, Treasure Hunt, Costume Party, a Clam Bake, plus the astonishingly beautiful scenery of one of New York State's loveliest resort areas.

By now, members will have received the Postal Announcement Card with information on rates, and other pertinent advice. In case you have mislaid or failed to receive a Postal Announcement, this will repeat some information. Rates at the Lake Placid Club range from \$18 to \$22 (subject to 15% service charge) per day per person, American Plan, which means that meals are included. Other information was outlined in the 90th Convention Announcement on page 643 of the August *Journal*, under "Rooms and Reservations."

If you telephone, wire or write for reservations, cite the SMPTE Convention and address: *Reservation Manager, Lake Placid Club, Essex County, N. Y.* Note that the Club's address and its own Post Office are in Essex County: they are not in Lake Placid.

Although the entertainment and diversions provided both for the Ladies Program and for everyone attending the Convention are very extensive, including as they do all the sports facilities of the Club — tennis, swimming, boating, golf, etc., the emphasis is, as always, on the excellence of the Papers Program.

Titles and abstracts of many very special papers appear in the Advance Program on the following pages. The Monday Evening Session on Visual Presentation includes a paper on the midwest program on airborne educational television, a discussion of classroom films and a paper on integrated projection — in addition to a 90-minute demonstration of equipment. Other items of special interest include a paper on liquid-gate projection for large-screen pictures scheduled for the Friday Afternoon Projection Session, a panel discussion on Pay TV and several interesting papers on space photography.



C. Loren Graham
Chairman, 90th Program

Coffee Shop: The Co fee Club, traditionally the social center of the Convention for refreshment and conversation, is sponsored by Philip A. Hunt Company of Palisades Park, N. J.

Outline of Program

Sunday
- 10:00–5:00 Registration

Monday
- 8:30 Registration
- 9:00 Space Photography and Image Sensing
- 12:15 Get-Together Luncheon—Guest Speaker: Barton Kreuzer
- 2:00 Business Meeting
- 2:15 Instrumentation and High-Speed Photography
- 8:00 Systems of Visual Presentation

Tuesday
- 9:00 CONCURRENT SESSIONS
  Laboratory Practice
  Instrumentation and High-Speed Photography
- 2:00 8mm Professional Prints; Audio-Visual Techniques
- 8:00 Presentation of Awards
  Guest Speaker: Lt. Col. John A. Powers, Public Affairs Officer, Space Task Group, NASA

Wednesday
- 9:00 Sound Reproduction
- 2:00 Panel Discussion: Subscription TV
- 6:45 Cocktail Party, Dinner, Dance

Thursday
- 9:00 TV Equipment and Techniques
- 2:00 TV Recording

Friday
- 9:00 Cinematography
- 2:00 Projection

Advance Program

This program is as complete and accurate as possible at press time—but there may be errors and there probably will be some changes for the Final Program. If attendance at a session is now being planned for only a specific paper or two, members are advised to inquire during the week before the Convention by telephoning to SMPTE Headquarters in New York (LOngacre 5–0172) or to Dr. C. Loren Graham, Program Chairman, in Rochester, N.Y. (GLadstone 8–1000, Ext. 3621 or 3929).

SUNDAY—OCTOBER 1

10:00–5:00 Registration

MONDAY—OCTOBER 2

8:30 Registration

9:00 SPACE PHOTOGRAPHY AND IMAGE SENSING

The Operational Aspects of Image Transmission Systems

JOHN MANNIELLO, CbS Laboratories, Stamford, Conn.

The operational use of image transmission systems, wherein radar, infrared and photographic intelligence is transmitted from an airborne vehicle to a command post, is intended to provide military commanders sufficient decision-making time in situations where reaction time is limited to seconds rather than days. Operational aspects of specific systems are discussed.

A High-Resolution Ground Station Recorder With Direct Film Exposure by Electron Beam

JOHN A. STUMPF and W. K. BERTHOLD, Radio Corp. of America, Hightstown, N.J.

The technique of exposing photographic film by means of an electron beam in order to obtain high-quality recording of TV-type picture information is discussed. The application of this system to the recording of high-definition TV-type signals received from satellites appears to be especially attractive. The results of exploratory experiments made with preliminary apparatus are presented. Details of the construction of a feasibility model are outlined together with typical results obtained from operational tests.

The Interpretation of Cloud Pictures From the Tiros Meteorological Satellites

JOHN H. CONOVER, Geophysics Research Directorate, Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Mass.

Interpretation of the Tiros cloud pictures, which were taken from an altitude of 725 km above the Earth, depends on the cloud brightness, texture, structure, pattern, shape and the dimensions of the patterns and shapes. Methods of determining the location of the pictures and rectifying them to a suitable scale to obtain dimensions, patterns and shapes are discussed. Transmission to the weather services, the use of grid overlays, the production of rectified photographic mosaics, and a cloud identification guide are described. Methods of automatically obtaining brightness, which may prove feasible for routine use, are shown.

A Theory for Visual Detection and Recognition of Blurred Images on Grainy Film

ROBERT E. HUFNAGEL, Perkin-Elmer Corp., Norwalk, Conn.

A mathematical model has been developed which predicts the ability of humans to detect or recognize the images of simple objects as recorded through limited resolution systems on grainy film. The model is based on the assumption that a human observer behaves as a mathematically perfect device except for some limitations and imperfections which can be simply and objectively described. Comparisons between theory and experiments show good agreement.

See page 748 for Tentative Schedule of Committee Meetings.

Application of Sine-Wave Response Techniques to Image-Forming Systems

ROBERT LAMBERTS, Research Laboratories, Eastman Kodak Co., Rochester, N.Y.

Sine-wave response has proved to be a powerful tool for appraising systems using lenses, photographic emulsions, television systems, and other image-forming devices. This paper describes techniques for such analyses of various components of optical systems.

A Versatile Tracking Mount for Systems Evaluation

GEORGE G. SILBERBERG, RICHARD W. MACE and JULIAN L. THOMPSON, U. S. Naval Ordnance Test Station, China Lake, Calif.

In the past, tracking mounts have been fabricated to meet definite data gathering requirements. Now, a tracking mount has been specifically designed to be used to evaluate all the components of various tracking and data gathering systems. The tracking systems include tracking loops composed of various electrooptical displays and control mechanisms, whereas the data gathering systems include photooptical and electronic sensing devices and recorders. Human factors problems are being considered in evaluating tracking systems compatibility.

12:15 Get-Together Luncheon

Guest Speaker:
"Electronic and Motion-Picture Systems in the Space Age," BARTON KREUZER, Division Vice-President and General Manager, Astro-Electronic Products Division, Radio Corporation of America

MONDAY AFTERNOON

2:00 BUSINESS MEETING

2:15 INSTRUMENTATION AND HIGH-SPEED PHOTOGRAPHY

Optical Instrumentation at Vandenberg Air Force Base

CHARLES P. BRADLEY, 1352d Photographic Squadron, Lookout Mountain Air Force Station, Los Angeles

The work that the 1352d Photographic Squadron, Air Photographic and Charting Service, is accomplishing in the field of photographic instrumentation for missile tests at Vandenberg Air Force Base, Calif., is described and illustrated by a 35mm sound motion picture.

The Design and Operational Philosophy of the Ballistic Camera Systems at the Atlantic Missile Range

A. E. GLEI, RCA Service Co., Patrick Air Force Base, Fla.

General background information on the use and philosophy of the ballistic cameras used at Atlantic Missile Range in a new but proven science, Photogrammetric Triangulation, is presented. The techniques and equipments used have proven to be the only means of providing the accuracy required for evaluation and calibration of the sophisticated electronic guidance and tracking systems required for our space and missile programs. The performance of the system has already demonstrated a sound instrumentation and engineering approach, and the system is recognized throughout the missile industry as the "Range Standard."

A Study of Explosive Flash Components for Enhanced Light Output

DAVID C. OAKLEY, Lawrence Radiation Laboratory, University of California, Livermore, Calif., and HOWARD G. HANSON, Physics Department, University of Minnesota, Duluth, Minn.

Some possible gas enclosures for explosive flash units are compared to give the optimum white light output. Facing materials are compared for transmission vs. time. Argon gas purity requirements are described. Comparison of argon and xenon gases is made. Use of spectral shifters to make use of the energy in the ultraviolet is considered.

Role of Fiber Optics in High-Speed Photography

N. S. KAPANY, Optics Technology, Inc., Belmont, Calif.

Recent developments in the field of fiber optics have made possible scanning and dissection of images with high spatial and temporal resolution. Such fiber optical configurations in the form of image dissectors can be used for high-speed photography, cathode-ray-tube photography, and other optical scanning systems. Experiments using the fiber optics image dissector with a rotating-drum high-speed camera are described; photographs yielding time resolution of 10^{-7} and higher have been achieved.

New Optics for High-Speed Photography

CARLOS H. ELMER, Traid Corp., Encino, Calif.

Several types of new optical systems for use with high-speed rotating prism cameras have been developed during the past year. These include periscopes with 1:1 magnification in both right-angle and straight-through configurations, 165° wide-angle optics for 16mm coverage, and illuminated fiducial marker systems.

New 500-fps Pin-Registration Intermittent Camera With Mechanical Servo Control

ROBERT L. RODGERS, D. B. Milliken Co., Arcadia, Calif.

The design principle of the unique rotational pin-register intermittent movement used in other cameras made by this company has been combined with advanced technology in the development of a new basic camera mechanism, capable of 500 frames per second with extreme reliability under abusive circumstances. New materials and techniques have permitted increasing operating efficiency and minimizing power requirements and maintenance. A newly developed mechanical servo control system facilitates a fully automatic movement. The adaptability of these mechanisms to specialized applications is demonstrated by reference to the recent operation of two cameras. Performance characteristics and potential applications are discussed.

MONDAY EVENING

8:00 SYSTEMS OF VISUAL PRESENTATION

The Midwest Airborne Television Experiment

JAMES S. MILES, Purdue University, Lafayette, Ind.

A New Approach to Classroom Films

DAVID G. ANDERSON, Yale University, New Haven, Conn.

Integrated Projection

A. TERLOUW, N. E. SALMONS and R. S. BEELER, Eastman Kodak Co., Rochester, N.Y.

Projection outside of the theater is taking place with increasing frequency; the conference, the seminar, the assembly line, the office and the library are examples. In most instances the projected image must be used as a reference when engaged in either clerical or manipulated activities. In other instances the projected image is consulted simultaneously with other modes of display. Requirements of brightness, field characteristics, image size, and equipment control are quite different from those of the theater. These situations are described, demonstrated and analyzed.

Model equipment to illustrate these concepts and principles will be set up and demonstrated. The presentation and demonstration will last about 90 minutes.

TUESDAY MORNING—OCTOBER 3

CONCURRENT SESSIONS

9:00 LABORATORY PRACTICE

Use of Split-Frame Technique in Motion-Picture Investigations

DAAN ZWICK and CHARLES OSBORNE, Research Laboratories, Eastman Kodak Co., Rochester, N.Y.

The split-frame technique consists of exposing the two halves of a negative or print in separate exposure operations. By means of this technique, many of the unwanted variables of photographic tests can be eliminated. In tests of lighting, make-up, filters or cameras, for example, exposing the negative split-frame permits common negative process, printing and projection operations. Split-frame printer tests permit common print stock, print process and projection, thus minimizing these variables. The final convenience is the side-by-side comparison without special projection equipment.

Examples from a negative filter test, various printer variations and a graininess investigation are demonstrated.

Screen Quality and Its Relationship to Process Control

ROBERT O. GALE, Color Technology Div., and ALLAN L. WILLIAMS, Film Testing Div., Eastman Kodak Co., Rochester 4, N.Y.

Screen quality is directly related to the control exercised in the processing of the negative, intermediate, and print films. Some of the more common chemical and mechanical processing conditions that must be maintained under control to avoid inferior screen quality in the system using Eastman Color Films are described. To demonstrate the effects of some of these variables, a side-by-side picture comparison is presented, using the split-screen technique described in the previous paper.

Ultrasonic Splicing of Polyethylene Terephthalate Films

F. P. ALLES, Photo Products Dept., E. I. du Pont de Nemours & Co., Parlin N. J.

A systematic study covering six variables shown by preliminary tests to be most important in splicing "Cronar" polyester base by the application of ultrasonic energy showed complex interactions. However, a good operating range was found which yielded useful splices, without scraping of the emulsion, with as little as 0.010 in. overlap and splices as strong as the base itself at an overlap of 0.030 in. The splicer designed and used in these studies could handle 8, 16, 35 and 70mm films and hence permitted tests covering a wide range of conditions of use.

Transistorized Control System for Printer Light Change

MARIO CALZINI and MASSIMO CATURELLI, Tecnostampa, Rome, Italy

The position of the light-changing notch on negatives may not be standard, which may result in a problem if a negative is printed in more than one laboratory. To overcome this problem, a device has been designed that detects the notch and produces a delay adjustable to 1/36 of a frame by means of a transistorized binary counter without relays. The solenoid operating the light changer is actuated by a power transistor. The unit is in a small housing containing several plug-in modules on printed circuit cards for easy replacement and interchangeability.

Automatic Additive Color Printing—A New Concept

HANS CHRISTOPH WOHLRAB, Bell & Howell Co., Chicago

Among the many improvements of a redesigned automatic additive color printer are a faster acting memory device with a new type of light valve incorporating 74 steps of 0.025 log E, a six-speed tape controlled fader, a zero light cutoff, automatic torque control of tight winds, a new lamp source, and plug-in type relays. Safety of operation and ease of servicing were prime design specifications.

A Programming Device for Automatic Color Printers

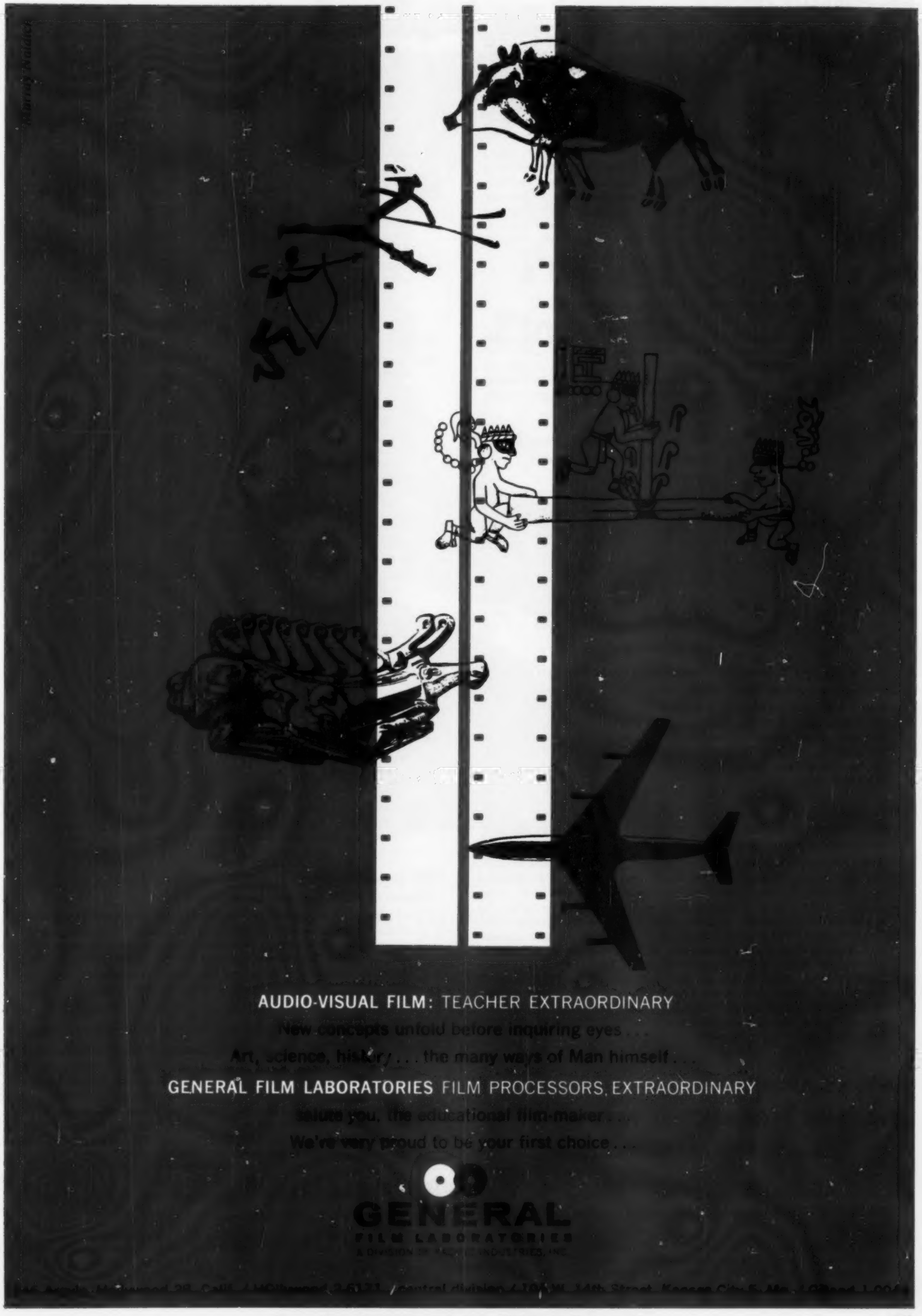
HANS CHRISTOPH WOHLRAB, Bell & Howell Co., Chicago

Using a standard-width business tape the programmer punches the code for 50 steps of light in each of the three color beams, controls six fade lengths and a zero light plus start and stop. The same device can be used for monochromatic printing.

A Method of Printer Cuing by Removable Aluminum Patches on Film

HANS CHRISTOPH WOHLRAB, Bell & Howell Co., Chicago

An aluminum patch on the film damps the radio-frequency oscillations in a probe by induced eddy currents. This effect is amplified and triggers a cuing relay. The probe does not touch the film. The patches are easily removable.


AUDIO-VISUAL FILM: TEACHER EXTRAORDINARY
New concepts unfold before inquiring eyes . . .
Art, science, history . . . the many ways of Man himself . . .
GENERAL FILM LABORATORIES FILM PROCESSORS, EXTRAORDINARY
salute you, the educational film-maker . . .
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CONCURRENT SESSION

9:00 INSTRUMENTATION AND HIGH-SPEED PHOTOGRAPHY

A True Kerr-Cell Framing Camera

S. M. HAUSER, D. MARLOW, H. QUAN, R. SILVER and P. BUTTON, Electro-Optical Instruments, Inc., Pasadena, Calif.

This paper describes a Kerr-cell framing camera incorporating a multifaced prism which directs a portion of the energy collected by a primary objective lens through each of six separate Kerr-cell shutters. Separate images of the same event from the same aspect and through the same set of optics are thus possible. Using established triggering techniques, framing rates to 10^8/sec are achieved at exposure times in the range of 5 to 10,000 nsec. Exposure time and resolution are independent of framing rate.

Kerr-Cell Photography in Plasma Physics

STANLEY L. LEONARD and EUGENE B. TURNER, Aerospace Corp., Los Angeles

A Kerr cell shutter (made by Electro-Optical Instruments, Inc.) has been used in this laboratory for the photography of high-temperature, transient deuterium plasmas confined by magnetic fields. The inherent advantages of high resolution, short exposure durations, and reliability are valuable for this type of work. Photographs of plasmas produced by both linear and theta-pinch devices are shown.

A Photographic Recording Technique for Measuring High-Speed Motion-Picture Camera Image Steadiness

A. E. QUINN, Eastman Kodak Co., Rochester, N.Y.

A method of evaluating both vertical and horizontal high-speed motion-picture camera image steadiness using a double exposure technique on high-speed camera film is described. The first exposure is made in a conventional pin-registered camera to record a latent image reference exposure. The film is then re-exposed in a high-speed motion-picture camera to record the identical target somewhat displaced from the first image. After processing, the 100-ft test film is projected through a slit onto a slowly revolving drum containing a 35mm strip of photorecording material. A double trace results which shows the relative differential between the reference camera and the high-speed camera.

Universal Timing System for Photoinstrumentation

G. H. HEARON and L. H. REED, Benson-Lehner Corp., Washington, D.C.

This system is comprised of a central control, distributor unit, and camera display. It allows time to be recorded on all cameras in an instrumentation system simultaneously and with a time resolution of one millisecond. It utilizes computer counting techniques and Nixie display tubes. Time is presented in Arabic decimal on the frame at the frame being exposed.

Thirty-Nanosecond Radiography

W. P. DYKE, F. J. GRUNDHAUSER, F. M. COLLINS and N. W. STUNKARD, Field Emission Corp., McMinnville, Ore.

The newly practical field emission electron source has considerable radiographic significance in view of its very large current density, up to 10^8 amp/cm^2, or about a million times greater than that of the thermal emitter (heated wire) used in conventional x-ray tubes. As a result it is now possible to obtain high resolution radiographs (e.g., 2 mil) in very short exposure times (30 nanoseconds). In one application, a sharp radiograph was obtained of 7-mil particles traveling at a velocity of 16,000 fps. The present paper describes a new, small portable x-ray system which was developed for very high radiographic information rates; it also reviews briefly the recent, but earlier, development of higher voltage equipments based on the T-F emission cathode which operates at intermediate current densities (e.g., 1000 amp/cm^2) and information rates.

TUESDAY AFTERNOON:

2:00 8MM PROFESSIONAL PRINTS; AUDIO-VISUAL TECHNIQUES

The 8mm Movie Film System

A. C. ROBERTSON, Manufacturing Experiments Div., Eastman Kodak Co., Rochester, N.Y.

The present scope and rate of growth of the 8mm industry is discussed, as well as the history of standardization in the amateur field. The fundamentals of design which lead to economy of film and simplicity of operation of the camera are described with special reference to the problems brought in by the large number of manufacturers now making equipment. Because of improvements leading to bigger and brighter screens, a faster projection rate is needed to minimize flicker, and greater steadiness is needed as well. Cancellation is described briefly, and considerable attention is given to the problems imposed on the industry by the current activity in the field of amateur magnetic sound recording. The new standards proposals under consideration are discussed briefly.

Utilization of the 35/32mm Method for the Production of 8mm Prints

FRED J. SCOBEY, General Film Laboratories, Hollywood

The production of 8mm release prints using four rows of 8mm across 35/32mm as presently in use at General Film Laboratories is considered. Use of existing printing and developing equipment and the economy of handling the products four at a time, as well as new equipment for release printing, striping and recording, is discussed, with emphasis on the importance of the professional approach to the 8mm print.

Commercial Systems for Making 8mm Prints

GEORGE T. KEENE and JAMES D. CLIFFORD, Color Technology Div., Eastman Kodak Co., Rochester, N.Y.

Many printing systems leading to 8mm release prints were critically examined, and a few selected systems are illustrated with motion pictures. With conventional printers, satisfactory 8mm release prints can be made only from originals 16mm or larger. A comparison is made between a camera original on 8mm Kodachrome II Film and 8mm prints derived from both 16mm Ektachrome Commercial Film and 35mm Eastman Color Negative Film.

Teaching Machines: A Challenging Market for 8mm

HAWLEY A. BLANCHARD, Intellectronic Systems Laboratory, Ramo-Wooldrige, Canoga Park, Calif.

Teaching machines are a relatively new development offering much promise in improving educational practices. Using a variety of presentation modes and immediate reinforcement of appropriate behavior, they can be programmed to teach using the best educational and psychological principles. One estimate of the potential market, including programs and machines, is $100,000,000 for the period through 1965. 8mm film seems to offer the most promise for use in the more advanced teaching machines. An idealized 8mm film system, its functions and cost are discussed.

8mm "SOF" as a Professional News Medium for Television

RICHARD B. RAWLS, Meredith Broadcasting Co., KPHO Div., Phoenix, Ariz.

KPHO utilizes 8mm sound on film and equipment to supplement other picture media now being used in TV news coverage. The advantages of the 8mm medium, its limitations, and the methods which KPHO has developed in using 8mm successfully are discussed.

We Move the Earth in 8mm

WILLIAM C. DIETER, Dow and Co., Rochester, N. Y.

An effective 8mm sales film with sound and color was made to demonstrate the use of heavy earth-moving equipment. Problems peculiar to photographing such equipment as well as problems of shooting, editing, and dubbed-in musical background are discussed. The use of the film in sales presentation, including changing the sound commentary to meet requirements of a particular audience, is described.

8mm as a Means for Learning Motion-Picture Production

ROBERT S. BEELER, Sales Service Div., Eastman Kodak Co., Rochester, N.Y.

Current 8mm cameras and sound projectors offer a practical answer to problems of mastering motion-picture planning and production procedures. Beginners can use simple 8mm equipment to develop ability, whereas production practice with 16 or 35mm equipment may be prohibitively expensive, or require technical skills the beginner does not possess. Techniques learned with 8mm can be transferred to the planning and production of 16mm and 35mm motion pictures.

8mm? You're Kidding!

WILFRED SHAW, Jr., The DoALL Co., Des Plaines, Ill.

The use of 8mm film in a sales program is described. The development of the program, including problems of production, projection and use in sales promotion, is described and the future of the program predicted.

TUESDAY EVENING

8:00 PRESENTATION OF AWARDS

Guest Speaker:

Lt.-Col. JOHN A. POWERS, Public Affairs Officer, Space Task Group, NASA

The Astronaut: Space Flight From the Viewpoint of Man Inside the Vehicle

The speaker will discuss the historic flights into space with special reference to communication techniques and the combination of engineering and psychological problems involved in space navigation.

WEDNESDAY MORNING—OCTOBER 4

9:00 SOUND REPRODUCTION

"Motor-Boating"—A Laboratory Problem in 16 mm Sound Release Printing

GEORGE BOVA and ARNOLD SCHIEMAN, National Film Board of Canada, Montreal, Que.

An Electronic Indexing System for $\frac{1}{4}$-in. Magnetic Tape Use

W. D. HEDDEN and ROGER J. SNOWDALL, Calvin Productions, Inc., Kansas City, Mo.

In using a $\frac{1}{4}$-in. magnetic tape library in sound motion-picture production, the location of particular musical selections on $\frac{1}{4}$-in. materials is often time-consuming and tedious. A simple electronic indexing system that eliminates the necessity of listening to audible cues is described. Desired selections may be located in the high-speed modes of the tape deck. This system, with presently available tape decks, automatic threading and complete remote control, further enhances the musical scoring process.

The Case for Split 16mm

D. J. WHITE and A. N. BROWN, Magnasync Corp., North Hollywood, Calif.

In an era of constant progression toward ultimate miniaturization of equipment, the splitting of standard films for sound recording is normal and consistent. Improved head gap to magnetic film contact and greater compliancy in the medium make possible more compact film transport components. These and other advantages of split 16mm are discussed.

A Multiple 8mm Magnetic Sound Printer

E. A. CUNNINGHAM and GEO. W. COLBURN, Geo. W. Colburn Laboratory, Inc., Chicago

A machine to transfer sound from a 16mm magnetic master to four 8mm magnetic sound release prints at double speed is described.

Testing Magnetic Striping

ROBERT C. LOVICK, Color Technology Div., Eastman Kodak Co., Rochester, N.Y.

The characteristics of magnetic stripes that influence sound reproduction capabilities are discussed, particularly as they apply to 30-mil strips used on 8mm films. Tests to determine potential performance are described and test equipment preparation reviewed.

Progress Report on Photographic Sound for 8mm Film

JOHN MAURER, JM Developments, Inc., New York

The projector and 8mm photographic soundtrack described in the paper which appeared in the August *Journal* of the Society will be demonstrated, and further progress up to the time of the Convention will be reported.

WEDNESDAY AFTERNOON

2:00 PANEL DISCUSSION: SUBSCRIPTION TV

Panel Discussion: The Engineering Aspects of Subscription TV

GENTRY VEAL, Moderator, Research Laboratories, Eastman Kodak Co., Rochester, N.Y.

The engineering equipment and methods used in four systems of subscription TV are presented as a panel discussion. The speakers and their affiliations are:

ERWIN M. ROSCHKE, Engineering Research Div., Zenith Radio Co., Chicago
CHARLES L. TOWNSEND, TelePrompTer, New York
AXEL JENSEN, Consultant
PATRICK COURT, International Telemeter Co., Div. of Paramount Pictures Corp., Los Angeles

The discussion will emphasize engineering; the economic and business aspects will not be included.

WEDNESDAY EVENING

6:45 COCKTAIL PARTY, DINNER, DANCE

THURSDAY MORNING—OCTOBER 5

9:00 TV EQUIPMENT AND TECHNIQUES

Stabilization of Monochrome and Color TV Cameras

K. SADASHIGE and HENRY KOZANOWSKI, Radio Corp. of America, Camden, N.J.

Television cameras and systems which are electrically stabilized to produce optimum picture quality with a minimum of operator attention have been developed. Such cameras have short warm-up time and long-term precision re-cycling characteristics. In this way, excellent resolution, registration, deflection linearity, and signal-to-noise ratio of the video signal are maintained. The approach has found broad application to stabilization of monochrome and color cameras, monitors, and film reproduction chains. It represents a growing trend to provide "black box" equipment to operate at peak performance with minimum attention.

Operationally Simplified Camera Channels

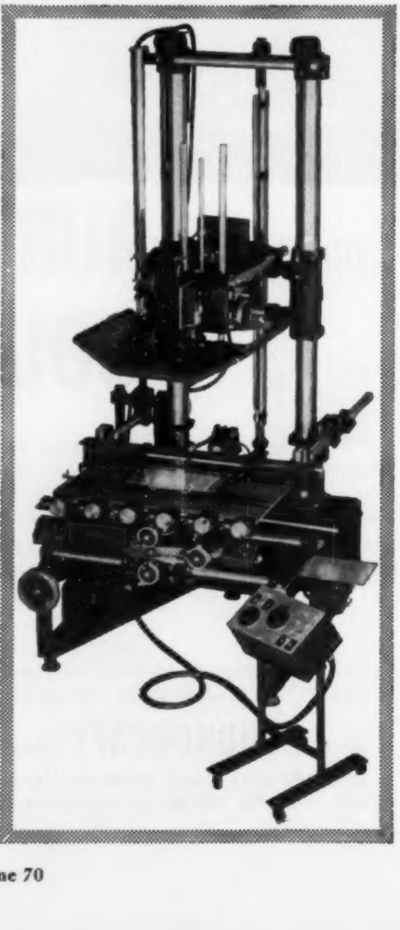
GEORGE E. PARTINGTON, Broadcasting Div., Marconi's Wireless Telegraph Co. Ltd., Chelmsford, England

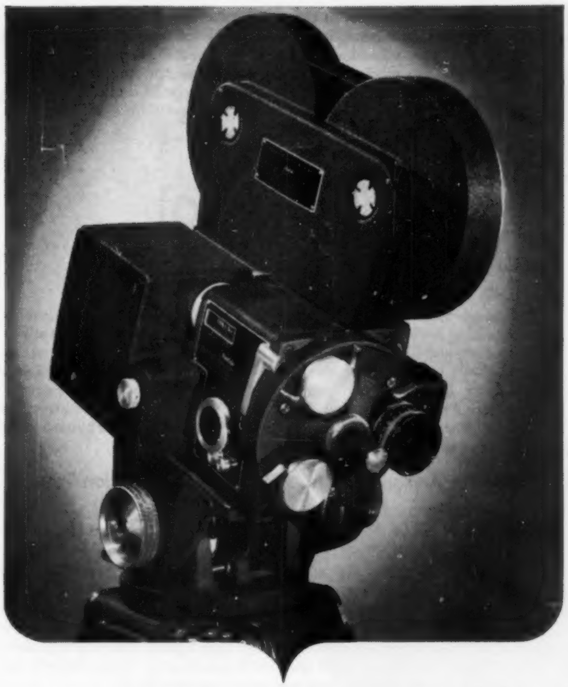
The development of camera tubes and channels having improved performance and stability make possible a considerably simplified vision operating technique: the so-called "hands off." This leads to economy in operating costs as well as improvement in picture quality. The influence of this concept on camera channel design is illustrated by reference to an image orthicon channel and a telecine vidicon channel; its implementation at several studio centers is briefly outlined.

Image-Orthicon Exposure Control

ALBERT CHEVALIER and VICTOR FERRY, Canadian Broadcasting Corp., Toronto, Ont.

CBC methods of image-orthicon exposure control, for both 3-in. and 4½-in. tubes, are described. Calibrated test objects and their problems and shortcomings are considered. Results obtained in controlled experiments are described as well as those obtained in daily operations. Methods of lighting by reference to a fixed set of lens apertures are considered with reference to the problems of evaluation of results with current monitoring techniques.





NEW KODAK REFLEX SPECIAL CAMERA (16mm)

At a price barely out of the amateur class, its combination of cinematic instrumentation features is unique.

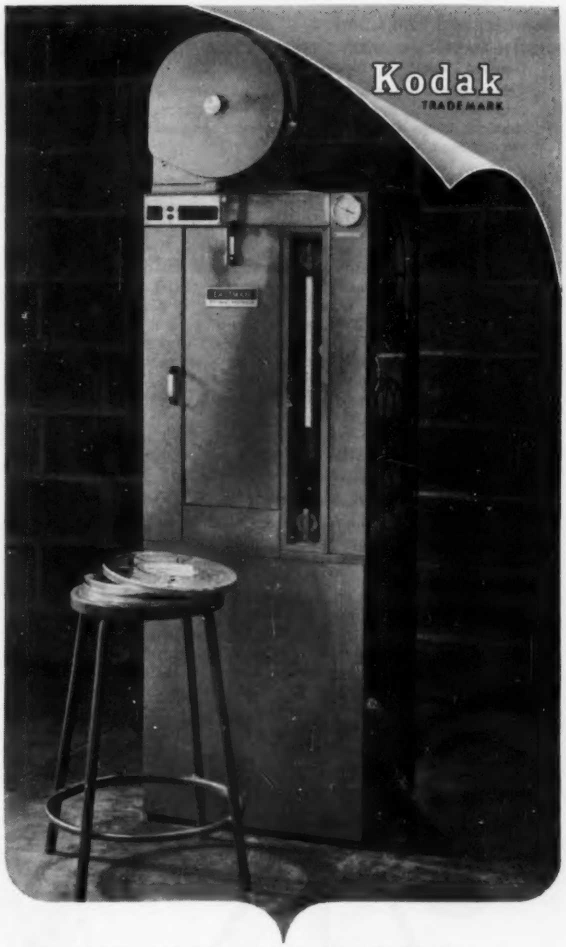
$1,895

Kodak has put 10 years of work into creating this modern successor to the old "Cine-Kodak Special." Those who work professionally with 16mm film loved that old camera.

The successor has direct, continuous reflex viewfinding through all nine of its available taking lenses (all in R-mounts, including a really first-class new 17.5-to-70mm *f*/2.2 zoom lens). It has a variable-angle shutter for achieving special effects. It accepts the usual complement of attachments that professionals need. Synchronous motor drive is removable to let the camera accept time-lapse or variable-speed motor drives (both available). Comes with 400′ magazine to supplement 100′ internal capacity: 1200′ magazine also available. With the Kodak Magnetic Sound System (transistorized), the camera has all facilities for recording and monitoring a sound track.

This camera holds register properly for the newer kinds of film as well as the older ones.

Interested persons should call or write Eastman Kodak Company, Motion Picture Film Department in Rochester, New York City, Chicago, or Hollywood. We will suggest an arrangement to permit your thorough scrutiny of camera, accessories, and/or processor.



NEW EASTMAN VISCOMAT PROCESSOR

At the same speed as a projector runs, it processes 16mm film to super-fussy Eastman standards.

$12,500

One minute is all the film spends inside. It is treated by viscous chemicals, emerges at 36 feet per minute, even lubricated, ready for immediate projection.

No replenishers. No chemical testing, adjusting, or compensating. Just insert a new cartridge. Incoming water and outgoing exhausted chemicals flow through flexible hose.

Stop or start processing at will. Run reels up to 1200′, hour after hour. Press a button to stop. Press another button to re-start after a minute or a week. No loss of quality. No dust, no dirt.

Prices are F.O.B. Rochester, N.Y. and subject to change without notice.

EASTMAN KODAK COMPANY

Rochester 4, N.Y.

Transistorized Film Camera

HUGH H. MARTIN and HARRY T. TRAVERS, Studio & Industrial TV Eng. Sec., General Electric Co., Syracuse, N.Y.

Telecasting of film material requires stable operation of the electronic equipment and rugged mechanical construction. Electrical and mechanical design parameters of equipment designed for film transmission are discussed.

A High-Definition Vidicon Film Camera Chain

L. L. POURCIAU and C. E. TAGGART, GPL Div., General Precision, Inc., Pleasantville, N.Y.

GPL has reported previously the considerable improvement in resolution that can be obtained by operating the standard 1-in. vidicon with higher than normal magnetic focus field (80 gauss) and correspondingly higher focus voltage. Since less aperture correction is required, and since signal current can be higher than normal, improvement in signal-to-noise ratio results. Problems entailed in fitting this method of operation into a reliable high-quality film playback equipment are described. The resulting camera chain has a novel automatic exposure control device with very fast response and a wide control range, and has other automatic functions.

CBS-KNXT Hollywood Television Broadcasting Center

ROBERT B. MONROE, WILFRID B. WHALLEY and A. PIERCE EVANS, CBS Television Network, New York

The Columbia Broadcasting System recently completed and inaugurated television program service for the Los Angeles area from its new KNXT headquarters, a compact and efficient local station studio plant, located at Columbia Square, Hollywood. It incorporates many new engineering developments, improved equipment, and automation features to improve program quality, simplify operation, and reduce operating errors. Equipment includes highly stable vidicon film cameras, which require a minimum of operating adjustment, and a digital computer for automatic switching of audio and video program material. The audio, video and communication facilities of the plant are described.

Closed-Circuit Television System for X-ray Inspection

JAY P. MITCHELL and MERLE L. RHOTEN, Engineering Experiment Station, Ohio State Univ., Columbus, Ohio

The use of a closed-circuit television system as the imaging device in conjunction with X-rays as the radiation source has made possible an instantaneous, in motion, inspection system for studying materials and structures. The television camera uses a small area x-ray sensitive pickup tube as a sensing device. The x-ray image, displayed on the TV monitor picture tube, is enlarged approximately 30 times. The system performance is equal to results obtained from x-ray film radiographs of material thicknesses up to ¼-in. of steel.

THURSDAY AFTERNOON

2:00 TV RECORDING

A New All-Transistor Television Tape Recorder

A. H. LIND, Radio Corp. of America, Camden, N.J.

Although the transverse track TV tape recorder is a complex machine containing a wide range of electronic circuits, transistors and transistor circuit developments have reached a point where it is feasible to utilize transistors and semiconductor diodes exclusively in the design of a new recorder. In addition to being an all transistor design the new recorder contains a number of innovations in operational facilities and advances in circuit technology that result in a new attainment in performance for TV tape recorders.

Pixlock—An Advanced Servo System for Television Tape Recorders

A. C. LUTHER, Jr. and J. R. WEST, Radio Corp. of America, Camden, N. J.

A new servo system allows a TV tape recorder playback to be synchronized accurately with a local TV system. Both the headwheel and the capstan of the tape recorder are controlled from the video information played back from the tape so as to provide highly stable and reliable operation. With this system it becomes possible to perform the same types of transition effects between tape signals and local signals as have been customarily used with local signals only. These include lap dissolves, wipes, keyed inserts and other special effects.

A Signal Processing Amplifier for Television Tape Recorders

R. N. HURST, Radio Corp. of America, Camden, N. J.

A signal processing amplifier has been designed to process a substandard video signal with noisy sync, severe baseline disturbances,

insufficient set-up, etc., to eliminate these deficiencies and deliver at its output a signal with regenerated horizontal sync, cleaned and re-inserted vertical sync, completely clean baseline, and proper setup. In the case of color signals, the burst is also regenerated and re-inserted. Special circuits, systems, and a modular construction method developed specifically for this unit are also described. The device was designed basically for the RCA-TV Tape Recorder, but is expected to have wider application.

A Broadcast-Quality Non-Studio Instructional Television System

KEN WINSLOW and AL ISBERG, Educational Television Office, University of California, Berkeley, Calif.

An extremely sophisticated television system is used at the University of California, Berkeley, to solve problems of increasing student enrollments. At this stage of development, the key purpose is to originate regular lectures for larger numbers of students under existing classroom conditions. Working with available light (20 to 50 ft-c illumination) and using a stabilized 4½-in. image-orthicon camera, a videotape recorder and a wireless microphone, broadcast-quality pictures are produced for use in regular academic instruction to ease the pressure of faculty, student and classroom scheduling. This non-studio television system is both economical and efficient since only one and a fraction man hours are required for each hour of instructional television use.

A New Approach to Electronic Film Recording

HENRY BALL and LEWIS A. BRIEL, Radio Corp. of America, Hollywood

A new instrumented electronic film recording system featuring automatic exposure and contrast controls is described. The development of a new double-aperture camera employing a twinning optical system, a high definition cathode-ray display tube and other features designed to produce high-quality motion-picture film (kinescope) recording is also presented.

Novel Shutter and Intermittent for Video Recording Camera

W. A. PALMER, W. A. Palmer Films, Inc., San Francisco

A new video recording camera has been designed incorporating a shutter design which spreads the "picture splice" over a time interval of about 40 video lines, resulting in elimination of shutter-bar problems. An extremely rapid pulldown, required by the shutter design, is achieved by releasing energy stored in a spring. A fixed register pin locks the film during exposure to insure vertical steadiness.

Electronic Editing of Video-Tape Recordings

NORMAN F. BOUNSALL, Ampex International, Redwood City, Calif.

Hitherto, it has been possible to edit TV programs recorded on magnetic tape only by conventional cutting and splicing techniques. A fundamental advance in the state of the art now makes it possible to assemble program material or to insert scenes or commercials electronically into existing tapes, without physically cutting or splicing the tape. The equipment described enables the recorder to be started and stopped at random, allowing recordings containing costume changes, animation effects, etc., to be made on the Videotape (TM Ampex) Recorder.

FRIDAY MORNING—OCTOBER 6
9:00 CINEMATOGRAPHY

Advantages in Single-System Film Production

JOSEF BOHMER, Technical Film Program, IAM, Poughkeepsie, N. Y.

Practical solutions to the inherent drawbacks of single-system production have been developed. The sensitometric disadvantages can be overcome by adjusted exposure of the picture and soundtrack, and the composite print editing need not present a problem if transitions are carefully planned. The desire to release live action film reports of current computer engineering developments necessitated single-system production at IBM's Poughkeepsie Laboratory. Samples of these films will be used to demonstrate successful single-system production.

A Nonstandard Use of 16mm to Meet the 8mm Print Cost Challenge

HENRY C. MENGERINGHAUSEN and WILLIAM R. WITHERELL, Jr., Video Films, Detroit

The use of 16mm release prints in large-scale business and educational film distribution has been challenged by the apparent savings offered by

8mm release prints. The authors propose a nonstandard use of 16mm compatible with most existing sound and picture equipment to effect considerable economies in shooting, printing and shipment, when such costs are a major consideration. The proposed system retains the use of the full 16mm frame and its inherent image quality.

A New Reflex 16mm Camera

WILLIAM A. MARTIN, Apparatus and Optical Div., Eastman Kodak Co., Rochester, N.Y.

A new Reflex 16mm Professional Camera manufactured by the Eastman Kodak Company is described. It is intended to serve the nontheatrical field of industrial, commercial and TV photography. The description covers drive units, film chambers, sound system and other accessories to be used with the camera.

Improved Automatic Exposure Control

DAVID MacMILLIN, Bell & Howell Co., Chicago

Coincidence of the fields of view of the photocell and film is important in automatic exposure controlled cameras for certain types of scenes. The sensitivity of selenium photocells makes this difficult to achieve. The use of different focal length lenses and zoom-type lenses can aggravate the problem seriously. An 8mm zoom-type motion-picture camera is described as a solution to this problem.

A Test of Video Tape to Film in Educational TV

REID H. RAY, Reid H. Ray Film Industries, St. Paul, Minn.; JOSEPH T. McDERMOTT and WAYNE A. MAYER, KTCA-TV, St. Paul, Minn.

Educational TV stations have a problem of economically producing program material available within their area. This paper briefly outlines the methods used to produce, with portable-type equipment, three half-hour programs and the transfer of the edited video-tape material to 16mm projection prints.

The Motion Picture as a Tool in Medical Education

WARREN STURGIS, Sturgis-Grant Productions, Inc., New York

Those long associated with audio-visual education in the medical sciences have seen a tremendous growth in film production and utilization in the two recent decades. Better, more practical equipment has been made available, and—equally important—workable principles have evolved. Ideas that result in an understanding of the ingredients of a good film, theoretical, personal, and mechanical, are discussed and various film samples are projected.

The Use of Motion-Pictures in an Analysis of the Masticating Cycle

JUDSON C. HICKEY, M. WOELFEL and M. FRIEND, College of Dentistry, Ohio State University, Columbus, Ohio

A frame-by-frame projection of motion-picture film is used in an analysis of the human masticatory cycle. The position of the jaw on each frame is digitized on IBM cards and the information from the cards is plotted electronically to form a graphic tracing of the jaw movement. A knowledge of jaw movement during mastication is important in determining the tooth form for both fixed and removable dental restorations.

FRIDAY AFTERNOON

2:00 PROJECTION

Liquid Gate for the Projection of Motion-Picture Film

JOHN R. TURNER, PHILIP A. RIPSON, Jr., FREDERICK J. KOLB and ERIC A. YAVITZ, Eastman Kodak Co., Rochester, N. Y.

A liquid immersion gate for the projection of 35mm motion-picture film is designed to be attached for demonstration purposes to a Model XL Simplex Projector. The auxiliary equipment required is contained in a separate portable service unit. The frame being projected is held in sharp focus from center to edge in contact with thin layers of methyl chloroform liquid between glass plates. Drift out of focus is thus prevented resulting in improved sharpness of the projected image. The appearance in the projected image of support scratches on the film is also greatly reduced. The liquid used is contained completely in a closed recirculation system except for the escape of vapor to the exhaust pipe.

A New All-Transistorized Sound Projector for 16mm Motion-Picture Film

R. J. ROMAN and J. M. MORIARTY, Eastman Kodak Co., Rochester, N.Y.

A new 16mm motion-picture film projector featuring an all-transistorized sound system has been developed. Details of the sound system are discussed, and the expected contribution of transistorized sound systems to the future of audio-visuals is commented upon. Significant features of the overall projector system are described. The projector is an overhead-reel, 2000-ft capacity, machine with single-lever control, representing a major advance in ease and sensitivity of operation. Color slides are used to illustrate the description of the system.

Motion-Picture Projection Lenses

JOHN D. HAYES, Bausch & Lomb, Inc., Rochester, N.Y.

Improvement in the quality of motion-picture systems has required a re-evaluation of the optical characteristics and performance requirements of motion-picture projection lenses. Characteristics such as high contrast, balanced illumination and balanced aberrational correction are indicative of current projection requirements; rather than the more traditional requirements of high resolution, high speed and axially highly corrected lenses. Comparisons of design data and performance characteristics of 35mm and 70mm lenses corrected to these parameters are discussed.

A New 16mm Sound Projector for General Use

GEORGE F. KRTOUS, Bell & Howell Co., Chicago

A new 16mm sound projector has unusually high light output, high performance, rugged construction and light weight as features of the design. Special consideration was given to convenience of operation and to satisfying the requirements of the broadest possible group of equipment users.

A High-Quality $f/1.0$ Projection Lens for 8mm Use

W. H. VAN GRAAFEILAND, Eastman Kodak Co., Rochester, N.Y.

The introduction to the 8mm movie world of improved color films in the past year has raised the problem of providing new optical systems capable of realizing the full potentialities of these emulsions for high-quality, large screen projection. Traditionally the "Petzval" type of lens has been used for 8mm projection and has provided satisfactory performance at relative apertures up to $f/1.4$. For large screen projection of the new films, the screen brightness and image quality requirements demanded a new design approach. The new $f/1.0$ projection lens answers this demand in providing a quality of 8mm performance heretofore unequaled.

A Front-Projection System—An Easy Approach to Process Photography

JOSEPH L. ANDERSON and ROBERT W. WAGNER, Ohio State University, Dept. of Photography, Motion Picture Div., Columbus, Ohio

This is an inexpensive, space-saving substitute for travelling mattes and standard back projection. The plate is projected from the camera side but foreground subjects are self-matting because the axes of projector and camera lenses are made exactly coincidental. A reflex reflector screen of high efficiency permits slow emulsions and lower wattage incandescent projection light sources. In addition to the common process setup of foreground and plate in two separate planes, this method allows an actor to "go into the plate" through practical architectural pieces set in the screen.

See page 751 for the roster of Topic Chairmen who developed the subjects of this Program under Chairman C. Loren Graham.

Tentative Schedule of Committee Meetings

Wednesday, May 4

10:00 A.M. Papers Committee
11:00 A.M. Board of Editors
12:15 P.M. Editorial Luncheon
1:45 P.M. Publications Advisory Committee

Engineering Committees heard from by press time and tentatively scheduled to meet during the week are listed below. The final schedule will appear in the Convention Program. Committee members of all Engineering Committees scheduled to meet during the Convention will also be notified by mail.

Instrumentation and High-Speed Photography
Laboratory Practice
Sound
Standards
Television

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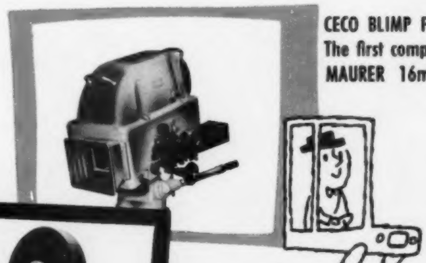

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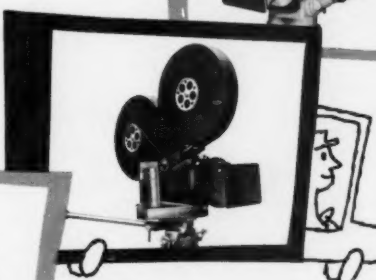

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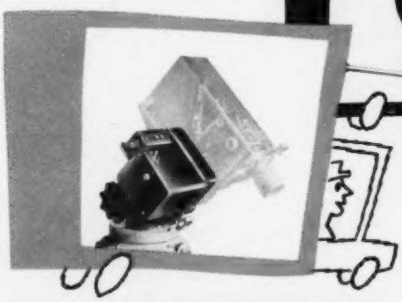

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- ☐ CECO Blimp for Maurer 16mm
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- ☐ MAGNASYNC 602 Type 13 Dubber
- ☐ NOMAD Transistorized Sound Recorder-Reproducer
- ☐ OXBERRY Unistand Model TE
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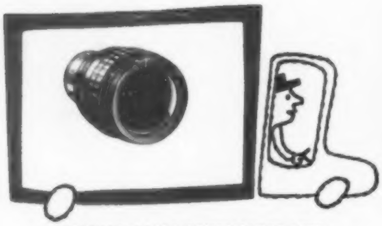

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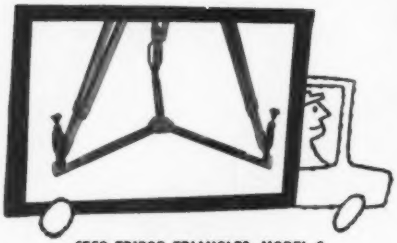

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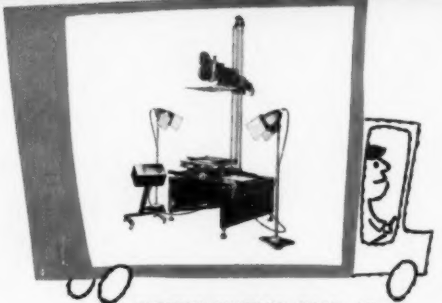

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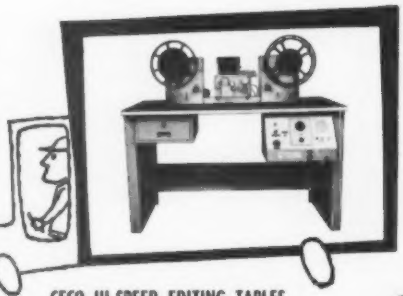

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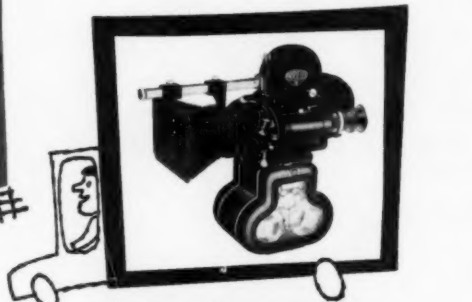

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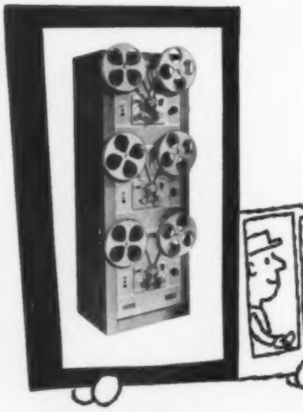

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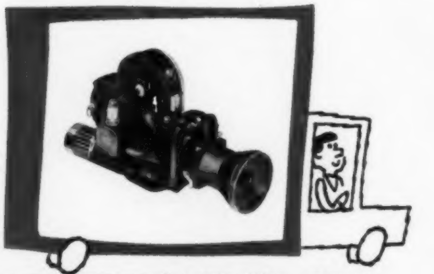

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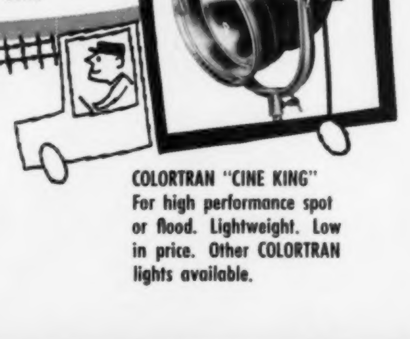

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Topic Chairmen for Lake Placid Convention

Space Photography and Image Sensing: RICHARD CALLAIS, Radio Corp. of America, Astro-Electronic Products Div., Princeton, N.J.

Instrumentation and High-Speed Photography: WILLIAM C. GRIFFIN, U.S. Naval Ordnance Test Station, China Lake, Calif.; *Co-Chairman*, MORTON SULTANOFF, Ballistic Research Lab., Aberdeen Proving Ground, Md.

Systems of Visual Presentation: ADRIAN TERLOUW, Eastman Kodak Co., 343 State St., Rochester, N.Y.

Laboratory Practice: GEO. W. COLBURN, Geo. W. Colburn Laboratory, Inc., 164 N. Wacker Dr., Chicago.

8mm Professional Prints; Audio-Visual Techniques: NEAL KEEHN, General Film Laboratories, 1546 North Argyle Ave., Hollywood, Calif.

Sound Reproduction: JOHN L. FORREST, Ansco, Binghamton, N.Y.

Subscription TV, Panel Discussion: *Moderator*, T. GENTRY VEAL, Eastman Kodak Co., Research Laboratories, Kodak Park, Rochester, N.Y.

TV Equipment and Techniques: RICHARD S. O'BRIEN, Columbia Broadcasting System, Inc., 485 Madison Ave., New York, N.Y.

TV Recording: NORMAN OLDING, Canadian Broadcasting Corp., P.O. Box 10, Snowdon, Montreal, Quebec.

Cinematography: WILLIAM D. HEDDEN, The Calvin Co., 1105 Truman Rd., Kansas City, Mo.

Organization and Operation of a Chain of Color Film Processing Laboratories

By ELDON E. BAUER

In 1955 the Eastman Kodak Company agreed to sell amateur Kodachrome films without including the cost of processing, and to issue licenses to independent firms equipped to process Kodachrome film. At present some twenty companies hold such licenses, among them Dynacolor Corporation of Rochester, N.Y., which operates on a national scale, with laboratories in Los Angeles, Dallas, Chicago, and Washington, D.C., as well as in Rochester. In 1960 this firm processed more than 10 million rolls of color films.

This firm was founded in 1949 and a few years later had developed a reversal color film of the Kodachrome type, marketed under the names of Dynacolor and McGregor Color, with sales eventually amounting to several hundred thousand dollars per year. By 1955 considerable experience had been gained in the operation of a process similar to that used by Eastman for Kodachrome film.

It was decided at that time that all available capital should be invested in increased processing capacity, and the manufacture of film was temporarily discontinued. Processing operations were moved to a larger plant in Brockport, N.Y., near Rochester, and five new processing machines were designed and built to meet the exact specifications of Eastman's Kodachrome process. In 1956, when Kodachrome film became available in quantity, Dynacolor was well prepared to handle it.

At that time it was decided that the firm would deal only through local photofinishers, who would serve as distributors for the company's processing service. By 1957 plans had been made for an East Coast station in Philadelphia and a Midwest station in the Chicago area, and since then plants have been established in Dallas, Tex., serving the Southwest, and in Los Angeles, serving the West Coast. The Philadelphia operation has been moved to Washington, D.C., because of the excellent airline service to the Southeast from that point. With the Rochester area plant serving the Northeast, Dynacolor is now in a position to give overnight color film processing service from one of its plants to a photofinisher customer in virtually any city in the United States.

It soon became apparent that it would be impossible to recruit sufficient experienced personnel at the supervisory and management levels to staff the new outlying operations. It was found, partly as a result of trial and error, that first and second echelon supervision could be supplied largely from within the organization by means of careful selection and the applica-

Presented on May 11, 1961, at the Society's Convention in Toronto by Eldon E. Bauer, Dynacolor Corp., 1999 Mt. Read Blvd., Rochester 15, N.Y.
(This paper was received on April 3, 1961.)

tion of accelerated training programs, but that plant managers could best be hired from other industries. Some of the most successful managers are men whose training and previous experience had been in industrial engineering and/or general business management, but who had had little experience within the photographic industry.

Each of the outlying plants is operated as an individual center, with considerable responsibility devolving upon the manager. The monthly profit and loss statements for the plants are prepared by the central accounting department in Rochester, on the basis of monthly inventories, weekly payroll figures, and daily production roll counts supplied by the plants.

Studies of plant operations indicate that direct labor costs have a greater influence on profits than any other factor over which the plant manager has immediate control. It is not uncommon, in a metropolitan area such as Los Angeles, for Monday's film receipts to amount to 33% of the week's total, and Friday's receipts as little as 9% of the total. Since every roll of film must be returned to the customer in 8 to 24 hours, the daily labor requirements are obviously highly unbalanced. Superimposed on this is the seasonal problem, with the volume in weeks following holidays running 100% above normal, and February volume averaging only half that of July. Increased use of prepaid processing mailers, on which the service requirements are not as stringent, has only partially alleviated the problem. Production forecasts, based on experience, and weekly labor efficiency reports applied to each plant by the Rochester accounting office, are useful tools, but conditions are constantly changing and a high degree of planning, aggressiveness, and ingenuity is required of each manager if he is to maintain his labor costs at or near the theoretical standards based on scientific studies.

Central control is maintained over process quality to insure that strict attention is given to this vital factor. Each plant is equipped with a complete control laboratory, and schedules of analysis of replenisher mixes and tank solutions are fully specified. Copies of the analytical results are forwarded to Rochester where long-range control charts are maintained on the chemistry of each plant. Each laboratory checks the reliability of its analytical procedures by means of a "standard sample" analysis program.

On the basis of hourly sensitometric controls and routine chemical and physical data, the process control supervisor in each plant determines what corrections should be made from time to time to keep the process operating at an optimum level. A random sample of the processed control strips is sent to Rochester daily where they are densitometered and each of the control parameters — color balance, speed and contrast — is plotted on a long-range chart. Any evidence of departure from standard is immediately communicated to the station, and if it persists the technical director visits the station to assist in correcting the problem. Practical picture tests, exposed under controlled conditions, are processed weekly in each station and sent to Rochester as a further check on process quality.

Since each station sends copies of its receiving records and shipping invoices to Rochester on a daily basis, it is possible to maintain a continuous service record for each account in the home office, and to alert the manager immediately if, by chance, he has not noted that a certain customer's shipments have dropped in volume or stopped completely.

Processing and related equipment is designed and manufactured by Dynacolor. Kodachrome couplers, 35mm readymounts, and other processing materials are also manufactured in the company's shops.

Processing equipment, developed as a result of twelve years operating experience, incorporates many novel features, including a feed-on elevator with a new-type crashless carriage and a film motion detector which automatically stops the processing machine and sounds an alarm four seconds after a break occurs in the film. The machine, which operates on the bottom drive principle, also incorporates a Dynacolor-designed tube-type rack which perfectly controls the film web in highly agitated developer solutions, thereby providing maximum insurance against breaks resulting from the film loops becoming entangled with each other or wrapping around the bottom rollers.

Other equipments designed by the firm include an automatic stapling machine for pre-splicing 16mm film, a tape splicing machine for 35mm film, and a roller bonder for sealing 35mm ready mounts at high

speed and with maximum safety to the film.

This processing equipment originally was manufactured solely for use in the firm's own processing laboratories. However, as a result of increased demand, Dynacolor-designed equipment was made commercially available beginning in January, 1961.

Although more photofinishers are now engaged in Kodachrome processing, Dynacolor's volume of Kodachrome film processing is still increasing slightly as a result of the growth in the total market. In addition, it is expected that a 20% to 30% increase in total volume will be realized in the coming year as a result of the company's processing of a color film of its own manufacture.

Education, Industry News

Test Film:

70mm All Purpose Alignment Film

Users of the Society's 70mm All Purpose Alignment Film (PA70) may now obtain this film in 40-ft rolls at a price of $22 per roll. This test film has previously been offered only in minimum length rolls of 100 ft each.

A two-day Audio-Visual Pictorial Equipment Show, sponsored by the Society's Washington Section, in cooperation with Trade Associates, Inc., will be held October 31 – November 1, at Marriott Motor Hotel, Twin Bridges, Washington, D.C. More than 50 exhibitors will show their latest equipment. Representatives of industry, education and government agencies throughout the United States will attend the show, as well as numbers of interested persons from the Washington, D.C., area.

This two-day show is indicative of the Washington, D.C., Section's plans for increasing effectiveness. The emphasis is on worthwhile meetings of more than routine interest, which means that the concept of holding regular meetings according to a fixed schedule has been abandoned in favor of seizing every opportunity to arrange dynamic, purposeful meetings to discuss timely topics.

William E. Youngs, Washington, D.C., Section Chairman, has reported that the Section has scheduled four meetings in September and October — two on the same day. On September 13, the Section plans to hold a Luncheon Meeting jointly with the Washington Film Council at which Thomas Hope will speak on Utilization of 8mm Sound Films, and that evening the Section will meet in the National Academy of Science to hear discussions by recognized authorities on the general theme of "The Story of 8mm Sound Film for Technicians and Lay-Visitors." Later in September the Section will spend an evening, arranged by Washington D.C., Section Manager Don Duke, at the newly remodeled studio of the U.S. Information Agency's Television Service.

High point of the two-month schedule of meetings will be the Audio-Visual Equipment Show. The Section will meet in the hotel at 7:30 P.M., October 31, the first day of the show. Technical papers on audio-visual subjects will be presented.

A new American Standards Association Sectional Committee on Magnetic Visual-Aural Recording Systems is being established in accordance with a proposal by the Society approved by the ASA General Conference on Magnetic Visual-Aural Recording. The Society has been named administrative sponsor of the new Sectional Committee which will consider all proposed American Standards for magnetic-tape recording. The new committee, to be composed of manufacturers, consumers and representatives of other interested groups represents the culmination of a series of discussions reflecting the early and continuing interest of the Society in the standardization of video tape, and the cooperation of the SMPTE, the IRE, the EIA and the NAB through the Joint Committee on Intersociety Coordination.

The SMPTE Video-Tape Recording Committee was established in June 1958 (Chairman, Howard Chinn). During its first year, according to a report presented at the Society's 1959 Spring Convention in Miami Beach by A. H. Lind (*Journal* pp. 612–614, Sept. 1959), the Committee formulated three Proposed American Standards and one Proposed Recommended Practice; and at the time the report was presented, four Proposed Standards and two Recommended Practices were in preparation. At the time the

SMPTE Video-Tape Recording Committee was established, a series of studies was initiated covering such items as tape dimension; tape reels; tape track dimensions; audio; control and cue track standards; monochrome and color signal characteristics; tape leaders; standard tape and tape splicing.

Peter S. Brown received the Outstanding Achievement Award in Television Production for 1960–61 from the Student Chapter of the University of Miami, of which he is a member. The award was presented in recognition of his work in producing and directing a television documentary commemorating the great war correspondent of World War II, Ernie Pyle. Produced as a class project, the documentary was broadcast over two Miami stations, WTVJ-TV and WTHS-TV.

The Detroit Section, the Society's newest Section, brings the Society's total to thirteen Sections plus five Student Chapters. Chairman of the new Section is William H. Smith, former Chairman of the Chicago Section, and who recently joined Allied Film Laboratory in Detroit. Secretary-Treasurer of the Detroit Section is James W. Bostwick and serving on the Board of Managers are: Robert F. Blair, Theodore T. Coleman, Dean Cook, Raymond A. Balousek, John A. Campbell and Howard W. Town. Philip E. Smith is Chairman of the Chicago Section, succeeding William H. Smith and William D. Hedden is successor to Philip E. Smith as Secretary-Treasurer of the Chicago Section.

A Conference on 8mm Sound Film and Education will be held November 8–10, at Teachers College, Columbia University. The conference will be sponsored by the Project in Educational Communication of the Horace Mann-Lincoln Institute of School Experimentation. Leaders in industry and education will participate in the conference. Papers will be presented exploring all phases of the subject, both technical and theoretical, and discussions are planned to analyze and evaluate factors now shaping the 8mm sound film field. The conference will include demonstrations of equipment and showings of 8mm sound motion pictures. The registration fee is $40. Further information is available from Professor Louis Forsdale, Teachers College, Columbia University, 525 W. 120 St., New York 27.

Courses in Film, Radio and Television offered by Columbia University, New York, for its Fall term, beginning September 28, include Film Production, Film Directing, Film Editing, Animation Workshop; Television Studio (nonengineering introduction); Professional Internship (TV) and others. These courses are part of a curriculm leading to the degree of Master of Fine Arts. However, most of them are open to special students on a noncredit basis.

The opening of the Washington, D.C., educational TV station operating on UHF Channel 26 was preceded by a two-weeks demonstration on July 15–28 sponsored by the Federal Communication Commission and the Greater Washington TV Association. Among products exhibited were translators developed by Adler Electronics, Inc., One LeFevre Lane, New Rochelle, N.Y., for converting and rebroadcasting VHF signals on UHF. The translators are automatic, low-power receiving and transmitting stations. Usually located at high point overlooking an area without adequate reception, the translator picks up signals from an originating station, and amplifies or converts them to a UHF channel for rebroadcast. Special antennas beam the signals toward schools and homes.

The American Federation of Information Processing Societies is a group of societies recently formed for the purpose of unified representation of the information processing sciences in the United States. It is successor to the National Joint Computer Committee, the principal function of which has been sponsorship of the Eastern and Western Joint Computer Conferences. Founding societies of the new group are the American Institute of Electrical Engineers, the Association for Computing Machinery and the Institute of Radio Engineers. Additional information is available from J. D. Madden, System Development Corp., 2500 Colorado Ave., Santa Monica, Calif.; or from S. A. Lanzarotta, IBM Corp., 3424 Wilshire Blvd., Los Angeles.

A three-firm combination of Triangle Productions Ltd., Robert Lawrence Productions, and Taylor Video Corp., all of Toronto, Ont., offers TV production service announced as a "complete one-stop service to clients, from the creation or development of a program idea, through casting, production and the distribution of the end product on film or video tape." The combined facilities include five sound stages, a 50-ft mobile video-tape studio, specially selected audio and video systems and, 35mm and 16mm film facilities. Equipment also includes Ampex 1000C Videotape Recorders, which affords "convertibility to 16mm film for TV reproduction through the exclusive High Definition Telerecorder," described in the announcement as "the only one of its kind in North America." Extra services are announced as closed-circuit TV facilities, viewing theaters, directors, producers, writers, technicians, engineers and camera crews.

The new National Camera Repair School Student Service Building, now under construction at 2000 W. Union Ave., Englewood, Colo., will permit expansion of the school's present manufacturing facilities. Constructed of masonry and two stories high, the new building will contain an auditorium and will also house an extensive library of photographic reference books. It will also provide additional office space. The National Camera Repair School is the only such school accredited by the Accrediting Commission of the National Home Study Council. The school's mailing address is National Camera Repair School, Box 174 NB, Englewood, Colo.

The 1961 engineering award of the National Academy of Television Arts and Sciences was presented jointly to two British and one American firms in recognition of the independent development of the 4½-in. image orthicon. The British Broadcasting Co., Marconi's Wireless Telegraph Co. Ltd., and the Radio Corp. of America shared in the award. Attending a celebration commemorating the first time this award has been presented to a firm outside the United States were W. Proctor Wilson, Head of Research, BBC; Sir Noel Ashbridge, a director of Marconi's Wireless Telegraph Co. Ltd., and F. C. McLean Deputy Director of Engineering, BBC.

Burroughs Electronics, Inc., River Road, Cos Cob, Conn., is a recently formed research and development organization. Founder and President is Gordon S. Burroughs. The new firm will specialize in the fields of radio direction finding, aerial navigation, infrared, reconnaissance, analog computers and other products for military, industrial and space agency use. Special emphasis will be placed on the fields of Moon and space exploration as well as satellite applications.

A new division of EMI/US, Ltd., 1750 N. Vine St., Los Angeles 28, known as the General Communications Division, will combine operations of the recently acquired General Communications, Inc., of Fort Atkinson, Wis., and EMI's Broadcast Division, according to a recent announcement. Products of the new division will include television cameras and equipment as well as switching equipment, solid-state video and pulse distribution equipment, special effects generators and automation systems. Formation of the new division is part of a major expansion program, the announcement states.

The Movie Supply of Hawaii, Ltd., Honolulu, has been appointed distributor for photographic and graphic arts chemicals produced by Philip A. Hunt Co., of Palisades Park, N.J. The New Jersey company specializes in the production of photographic, graphic arts and x-ray chemicals, which are distributed throughout the United States and in 22 foreign countries.

A two-day convention on television and film techniques held last April in London was highlighted by a demonstration of large-screen (12 by 9-ft) simultaneous color TV. It consisted of a color TV projector capable of accepting N.T.S.C.-type color TV signals by land line from the BBC studios at Lime Grove. The convention was jointly sponsored by the British Kinematograph Society and the Television Society.

A brief review of camera lens production in West Germany, beginning in 1952 when Eastman Kodak licensed the Schott

Company of Mainz to produce certain rare earth glasses of high refractive index for photographic use, has been released by the publication *Camera Industries of West Germany*. Recently developed lenses listed by the publication include the Schneider Variogon $f/1.8$ zoom lens for 8mm movies; the Zeiss Distagon 55mm $f/4$ 71° lens for the Wide Angle Rolleiflex; and the Leitz Summilux 35mm $f/1.4$ wide-angle lens for the Leica.

Claude Maillard has been appointed Manager of the Industrial Sales Department of the Gevaert Company of America, New York. In his new post he will be responsible for sales of industrial x-ray films, recording materials, microfilm, magnetic tape, and scientific films and plates throughout the United States. Prior to his present appointment he was the Denver District Manager.

Harvey C. Griffith, Jr., has been appointed Manager-Sales Planning and Promotion for the Technical Products Operation of the Defense Electronics Division, General Electric Co., Syracuse. N.Y. In his new post he will have charge of closed-circuit TV activities and will also engage in marketing research and planning for the firm's expanding market development organization.

Fraser Productions of San Francisco has announced two additions to its staff. William E. Tate has been appointed Director of Traffic and Production Controls and Miss Jeanne Pedder has been appointed Controller and Office Manager. The firm, which specializes in the production of training and instructional films for firms in electronics and similar industries, was founded in 1958 by Thomas H. Fraser. It is located in Columbus Towers.

Improved recording of the information relayed from satellites by television is the subject of work in progress at Kodak Research Laboratories since 1958. Charles H. Evans and Andrew Tarnowski of the laboratories in Rochester have been working on ways to "write" with electrons on film by removing the phosphor screen and permitting the electron beam to record directly on film. This eliminates energy losses and image degradation.

Because electrons have a greater effect than light on photographic film, a slow, fine-grain film can be used for the recording. The 16mm motion-picture film used in the experiments is 400 times slower than that normally used for kinescope recording. The film for recording is loaded in a modified motion-picture camera in a vacuum chamber at the screen end of a cathode ray tube. Electrons are accelerated by voltage in the tube and their movements controlled by magnetic fields, the film being scanned by the electron beam to create an image. Photographic factors such as contrast can be changed by varying the voltage used to accelerate the electrons in the tube.

The 4th International Conference on Medical Electronics, combined with the 14th Annual Conference on Electrical Techniques in Medicine and Biology, was held July 16–21 in New York. The meeting was sponsored by the Joint Executive Committee on Medicine and Biology (IRE, AIEE, ISA) under the auspices of the International Federation for Medical Electronics, and organized by the Institute of Radio Engineers through the Professional Group on Bio-Medical Electronics. About 300 technical papers were presented in 35 sessions during the week, and a number of workshops and round table discussions were held. Commercial exhibits and scientific displays by private institutions showed the latest developments in equipment and instrumentation in the medical electronic field.

A new American Standard, PH2.20-1960, American Standard Method for the Sensitometric Exposure of Artificial-Light-Type Color Films, has been formulated by the ASA Sectional Committee on Photographic Sensitometry, PH2. The introduction to the standard points out that a complete evaluation of a color photographic system does not yet seem to be a ready subject for an American Standard, but that standard techniques can be specified for some of the basic operations. The purpose of the present standard is to specify the manner of making a sensitometric exposure on artificial-light-type color film, and it is hoped that other phases of the sensitometry of color film will be incorporated into future American Standards. Copies of the new standard are available, at nominal cost, from the American Standards Association, Incorporated, 10 East 40th Street, New York 16.

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Obituaries

Frank V. Bremer

When the Society learned most regretfully of the death of Frank V. Bremer, assistance in preparing this obituary was very graciously given by his daughter, and son.

Frank V. Bremer, a pioneer of radio broadcasting, died on June 24, 1961, at the age of 67 after a short illness. He was founder of WAAT and for many years Vice-President of WAAT and its subsequent affiliate WATV.

Born in New York City, Mr. Bremer resided in Jersey City for a long period before moving to 12 Hamilton Avenue in the Arlington section of Kearny, N.J.

It was from his Jersey City home that active participation in Radio took place in 1909 by means of a spark coil transmitter under call letters F.B. In January of 1910 he formed the Jersey City Wireless Club. In 1914 amateur radio call "ARN" was assigned on 200 meters. One-kw power on a rotary gap was used. United States entry in World War I forced suspension of operations in 1917. Upon resumption in December of 1918 new call letters of 2IA were used.

Voice transmission was installed in 1919 employing a Heising Circuit. The next year saw the start of musical and news programs sponsored by the Jersey Review. An interesting highlight was that a ship dock in Liverpool, England, reported one of the broadcasts.

In 1922 call letters WAAT were issued for transmission on 360 meters at 15 watts power. Trouble, occasioned by low power and financial inability for expansion forced suspension in 1923.

The incorporation of Bremer Broadcasting Corporation in 1926 resulted in increased power to 100 watts but under call letters WKBD. Further negotiation resulted in restoration of the WAAT initials. Studios atop the Hotel Plaza in Jersey City were officially opened in November of the same year.

Growth of the industry resulted in transmitter facilities being erected in the Kearny meadows in 1940 with directional antenna system at 1-kw power. Studios and offices were moved to larger quarters in Newark two years later. Affiliation with the television field began in 1948 as WATV was officially opened on May 14 in Newark. Transmission of television signals was transferred to the Empire State building in 1953.

When the radio and television facilities were sold in 1958 to become known as WNTA and WNTA-TV, Mr. Bremer was retained as consultant until his retirement in 1960. At that time he was presented with a plaque commemorating his 50 years in broadcasting.

Along with membership in SMPTE Mr. Bremer was a senior member of the New Jersey Broadcasters Association, senior member of the Institute of Radio Engineers, the American Institute of Electrical Engineers, Radio Pioneers and the Empire State Television Guild.

While not a prolific contributor to technical literature, his articles were published in *Wireless Age* in 1919–1920.

A June 15, 1960, issue of the New Jersey Broadcasters Association news suggested, "someone should recommend to Mr. Bremer that it is time for him to write a history of New Jersey broadcasting from a broadcaster's point of view." Unfortunately such cannot come to pass. It's possible merit can be gaged by quoting the framed motto by Abraham Lincoln which hung over Mr. Bremer's desk.

> "I do the very best I know how
> — the very best I can;
> and I mean to keep doing so—"

His many friends mourn his untimely death because at this point in his lifetime he had so much to live for. He was planning a trip around the world in the near future and his frequent trips to Florida for fishing and to Canada for complete relaxation were his real pleasure.

We shall always remember him as the self-made man and one who always accomplished his goal. "Well done" Mr. Bremer, may your soul rest in peace.

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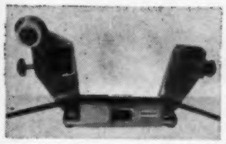

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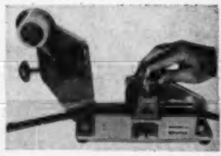
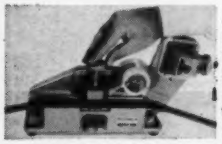


The cutting arm, shown in operating position, is used by pressing the chrome button for cutting both sides of the film simultaneously. The film, of course, has been registered on pins in the horizontal channel. The cutting blade is easily replaced when necessary.



The splicing tape is registered on precision pins and held in place until automatically applied to the film by swinging the arm over and pressing the chromed button. This action simultaneously cuts the adhesive and applied it—in perfect register to the film.

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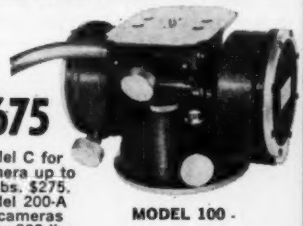

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Emery Huse

Emery Huse died July 7, 1961, at his home in Beverly Hills, Calif., at the age of 64. He was born in Newburyport, Mass., and attended George Washington University. In 1919 he joined Kodak Research Laboratories in Rochester. In 1926 he transferred to Kodak's Motion-Picture Film Department and in 1928 moved to Hollywood as Manager of the West Coast Division of the Motion-Picture Film Department. Widely known as an authority on processing and control procedures, his interest in that field began with the advent of sound films. Among the highlights of his career was his work on Eastman Color Film introduced about 1950, the acceptance of which was made possible, in large part, by technical service under his direction. A Fellow and a Past-President (1941–42) of the Society, he was a member of several other professional and scientific organizations. He retired on June 30, 1960. A Biographical Note mentioning details of his career and his contributions to the field, including publication of numerous technical articles, was published in the August 1960 *Journal*, page 564.

A. J. Patel

A. J. Patel died June 14, 1961, at his home in Bombay, India, at the age of 54. The Society was notified by his son, Shasikant A. Patel, also a member of the Society, who graciously contributed the following obituary.

One of the warmest and most colourful spirits in the international photographic world disappeared with the passing, at his fabulous home in Bombay, India, of Ambalal Jhaverbhai Patel, on June 14, 1961.

He was an artist, a business man, a philanthropist and an unquenchable lover of life, who never gave up his first devotion to the still camera, although India knew him as an industrialist and a theoretical film figure of heroic proportions.

Born in 1907 in a small town in Gujerat State, Western India, he was the son of a schoolteacher. In his childhood he knew no luxuries and could afford no hobbies, but he developed the spirit of free enterprise so early that at the age of six he earned school money by cutting "rubber" stamps out of a balsa-like wood and selling them to neighbourhood businessmen.

During high-school years he became interested in photography, and at the age of 18 answered an advertisement for a cameraman in Mombasa, British East Africa, where he filmed a "documentary" study of the visit of the then Prince of Wales (now the Duke of Windsor.)

In 1928 he returned to India and began work in the theatrical field as a cinematographer, but his interest in still photography persisted.

When Metro-Goldwyn-Mayer wanted some location stills on Northern India to help in set construction, he was selected to provide them and sent nearly five thousand stills — the most exhaustic location research job ever done on India for a foreign concern. The pictures were regarded as a top accomplishment in location photography.

Inspired by this success, he gathered some of his favourite photographs, and took off for the United States, en route to Hollywood. He held exhibitions of his photographs in a number of cities, and by the time he reached Hollywood had achieved a considerable reputation as a photographer of the exotic beauties of his home country.

In Hollywood, he served as technical adviser for the Twentieth-Century-Fox production of *The Rains Came.*

Back in India, he continued working as a still photographer, but now (since he had begun his career as an industrialist) as a hobby. He made tranquil studies of the shy women and children and the lovely landscapes of India a sort of personal


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trademark, and began to enter salons and photographic competitions in England, France, Germany, Switzerland and the United States.

He turned his attention to the technical side of the motion-picture industry, with the opening of Film Center, a large scale enterprise which launched major motion-picture colour processing in India.

His crowning achievement was the beginning, last year, of construction of the Patel Industrial Center, for the manufacture of cameras, projectors, tape recorders, and view-master stereoscopes.

Through inexpensive box cameras, now being produced at the rate of 50,000 a year, Patel hoped to put his beloved hobby within reach of most of his countrymen.

section reports

The Chicago Section met on June 20 at International Harvester's Hickory Hill Farm in Norway, Ill., with an attendance of 120. Guest speakers were from International Harvester: William Lane, Assistant Manager, Consumer Relations Dept.; and Harold F. Claus, General Supervisor of Visual Services.

Forty members and guests traveled to the Farm by chartered bus while an additional 80 persons went by private automobiles. At the Farm the group toured the grounds which comprises a 340-acre motion picture location. Following the tour, dinner was served at the Prairie Lake Hunt Club. After dinner the group returned to the Farm for a tour of the motion-picture studio facilities.

At the conclusion of the tour, the group assembled on the sound stage to hear a word of welcome from Mr. Lane. Mr. Claus later described the activities of IH's Film Department. The meeting ended with the screening of a film produced by International Harvester in cooperation with the U.S. Department of Interior.—*Philip E. Smith*, Secretary-Treasurer, c/o Kodak Processing Lab., 1712 Prairie Ave., Chicago, 16.

The Hollywood Section met on June 20 at KNXT Studio B with an attendance of 100. Due to the limited seating capacity of the studio, the meeting was open only to SMPTE members.

Section Chairman Ralph E. Lovell opened the meeting with a dissertation on the objectives, organization and growth of SMPTE. He was followed by Walter Beyer, Chairman of the SMPTE Film-Projection Practice Committee, who made a brief announcement regarding 70mm projection in drive-in theatres. Mr. Beyer is a member of the Board of Managers of the SMPTE Hollywood Section.

Later in the evening, Ed Miller and Bob Gross, Director and Engineer-in-Charge of KNXT Technical Operations respectively, presented a description of the new KNXT technical facilities, illustrating the latest concept of television plant design incorporating semiautomatic devices.

A pre-meeting dinner held at the Nickodell Restaurant was attended by 35 persons. —*John Kiel*, Secretary-Treasurer, c/o Producers Service Co., 820 South Mariposa St., Burbank, Calif.

The New York Section met on June 14th at Reeves Sound Studios with an attendance of 150.

Chet Stewart, President of Reeves Sound Studios, welcomed the group and outlined the "open house" procedure of the evening. Then he showed a TV tape on two monitors. The tape demonstrated soundtrack mixing operations, particularly on the Winston Churchill and Twentieth Century TV Series.

After the tape show, the Section members were escorted in groups of twelve throughout the five floors of the Studios. Mr. Stewart was assisted by a staff of ten which gave detailed answers to hundreds of questions on a variety of subjects, both technical and administrative.

On view, at close range, was the elaborate audio and video equipment used at Reeves for recording or dubbing video and sound. The equipment was not operated or demonstrated.

Our hosts for the evening were Mr. Stewart and Bob Byloff.—*Peter Keane*, Secretary-Treasurer, Screen Gems, Inc., 711 Fifth Avenue, New York.

The May 25 meeting of the Rochester Section, held at the Dryden Theatre, Eastman House, featured the reading of award winning papers prepared by members of the SMPTE Student Chapter and Delta Lambda Epsilon, photographic fraternity of Rochester Institute of Technology.

This was the second year of competition in which these two student organizations submitted papers both for course credit and for judging by an SMPTE panel. (Last year's top local student paper placed first in the Society's Student Competition.)

This year's first place award went to Cortland "Corky" Burt of Olean, and Richard Banks of Davenport, for their co-authored paper on high-speed processing of color negatives, suggesting a technique whereby film could be processed in about one-tenth of the time currently required by conventional processing.

Frank Cicha, Jr., Chicago, and Richmond C. Beach, Livonia Center, received honorable mention for their papers which compared the relative merits of two methods of making color prints from color transparencies.

Honorable mention was also given to Richard Walker of Brooklyn for his description of a unique densitometer which he designed and built.

Rudolf Kingslake, Director of Optical Design, Eastman Kodak Company, presented the awards.

The papers were judged by Wilbur G. Hill, Manager, Mechanical Development and Machine Design, Ansco; John Dessauer, Director of Research, Haloid-Zerox, Inc.; and George Higgins, Associate Head, Physics Division, Eastman Kodak Company.

This meeting afforded the winning students experience in the formal presentation of scientific accomplishments to the photographic industry. The calibre of the papers was high, marking as it did, the culmination of four years exhaustive study of photographic science and techniques.—*D. Lisle Conway*, Secretary-Treasurer, Maple Hill Farm, R.D. 2, West Monroe, N.Y.

First Prize winners in Rochester student competition Cortland Burt and Richard Banks; Richard Walker, who received Honorable Mention; Rudolf Kingslake, Director of Optical Design, Eastman Kodak Co., who presented the awards; and Frank Cicha, Jr. and Richmond C. Beach, both awarded Honorable Mention.

The San Francisco Section met on April 11 at KGO-TV Studio A. Guest speaker Norwood L. Simmons discussed the use of 16mm film in entertainment television. Dr. Simmons, Past-President of SMPTE, is Manager of the West Coast Division, Motion Picture Film Dept., Eastman Kodak Co.

Accompanied by charts and motion pictures, the speaker's examination of the important role of 16mm films in professional entertainment was very well presented.

While Dr. Simmons pointed out that 35mm film is generally considered the leading medium in the entertainment field, the unique adaptability of 16mm film to the television field has increased the popularity of that film. He showed that special techniques possible with 16mm are not possible with 35mm film.—*Clifton R. Skinner*, Secretary-Treasurer, c/o Skinner, Hirsch & Kaye, 336 Funston Ave., San Francisco 8.

The San Francisco Section met on May 9 at KGO-TV Studio A to hear Christ J. Condon, President of Century Precision Optics Co., North Hollywood, discuss "Telephoto and Long Focal Length Lenses."

Mr. Condon gave detailed descriptions of the problems in making telephoto lenses and their uses. He presented a picture which added interest to his talk. While his subject was quite technical everybody seemed to understand the subject. This was evidenced by the barrage of questions which followed after this meeting. He demonstrated principles with lenses produced by his company.

Since lenses are equally important to the television and motion-picture industries, this meeting had general membership appeal.

For the first time the Section meeting was opened with a short film. It was about Eastman's E 910 adhesive cement. Sample bottles of the cement were distributed and provoked some discussion after the screening.—*Clifton R. Skinner*, Secretary-Treasurer, c/o Skinner, Hirsch and Kaye, 336 Funston Ave., San Francisco 8.

The San Francisco Section met on June 13 at KGO-TV Studio A with an attendance of 36. Guest speaker was Joseph Roizen who spent one year in Europe inspecting Ampex Video-Tape Machines.

Mr. Roizen, who was accompanied to Europe by his family, told of many interesting experiences and illustrated his talk with motion pictures. He showed films of the Olympic games in Italy and several video-tape machines from different countries.

This was one of the most entertaining evenings that we have had and the Section is deeply appreciative of the time and effort that Mr. Roizen and his wife contributed to make it so.—*Clifton R. Skinner*, Secretary-Treasurer, c/o Skinner, Hirsch & Kaye, 336 Funston Ave., San Francisco 8.

The San Francisco Section met on July 11 at the University of California, Berkeley. The interesting and informative meeting on Problems and Solutions of Television in the Educational Field was arranged by Al Isberg and Ken Winslow.

Mr. Isberg's report on the progress being made in this field was based on information he had collected during an eastern tour of educational institutions. His discussion was illustrated with 16mm films showing instructive television.

Bill Palmer displayed his latest Motion Picture Video Camera following Mr. Isberg's talk. There was great interest in this piece of equipment, the showing of which had not been previously announced.

Prior to the meeting, the group attended a social hour and dinner hosted by Mr. and Mrs. Isberg at the faculty club house. —*Clifton R. Skinner*, Secretary-Treasurer, c/o Skinner, Hirsch & Kaye, 336 Funston Ave., San Francisco 8.

Abstracts

Abstracts from other Journals, chosen for importance and timeliness, are published in the *Journal* from time to time. The greater number of these abstracts are translations, chiefly from the U.S.S.R., and made available by the *Kodak Monthly Abstract Bulletin.*

The subject areas are grouped below

Aerial Photography
Cameras and Equipment (Except High-Speed)
Color Photography and Color Development
Film and Its Properties
Film Processing Apparatus and Chemicals
High-Speed Photography and Instrumentation
Printing and Optics
Projection Light Sources and Screens
Sound Recording and Reproduction
Television
Video Tape

AERIAL PHOTOGRAPHY

Processing High-Speed Panchromatic Aero Films (in Russian), K. I. Markhilevich, V. L. Abritalin and (Pt. I) I. I. Pyatkin, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 110–125, No. 35, 1960; *Tekh. Kino i Televideniya, 4:* 92, Nov. 1960.

I. Processing Conditions of Aero Film in a Manually Operated Developing Machine: A review is made of the literature on the influence on the degree of development of panchromatic aero film on resolving power. A formula is proposed for the relation between the time of development and the length of the film, and the results of a test on the influence of the speed of rewinding on the sensitometric values are given.

II. The Cyclic Development of Aero Film: In order to obtain proportional increase in the coefficient of contrast and speed with a permissible fog value, the method of cyclic development has been proposed for the PP-4M manual developing machine. It has been shown that the method of cyclic development gives positive results in increasing film speed and uniformity of development along the length of the film.

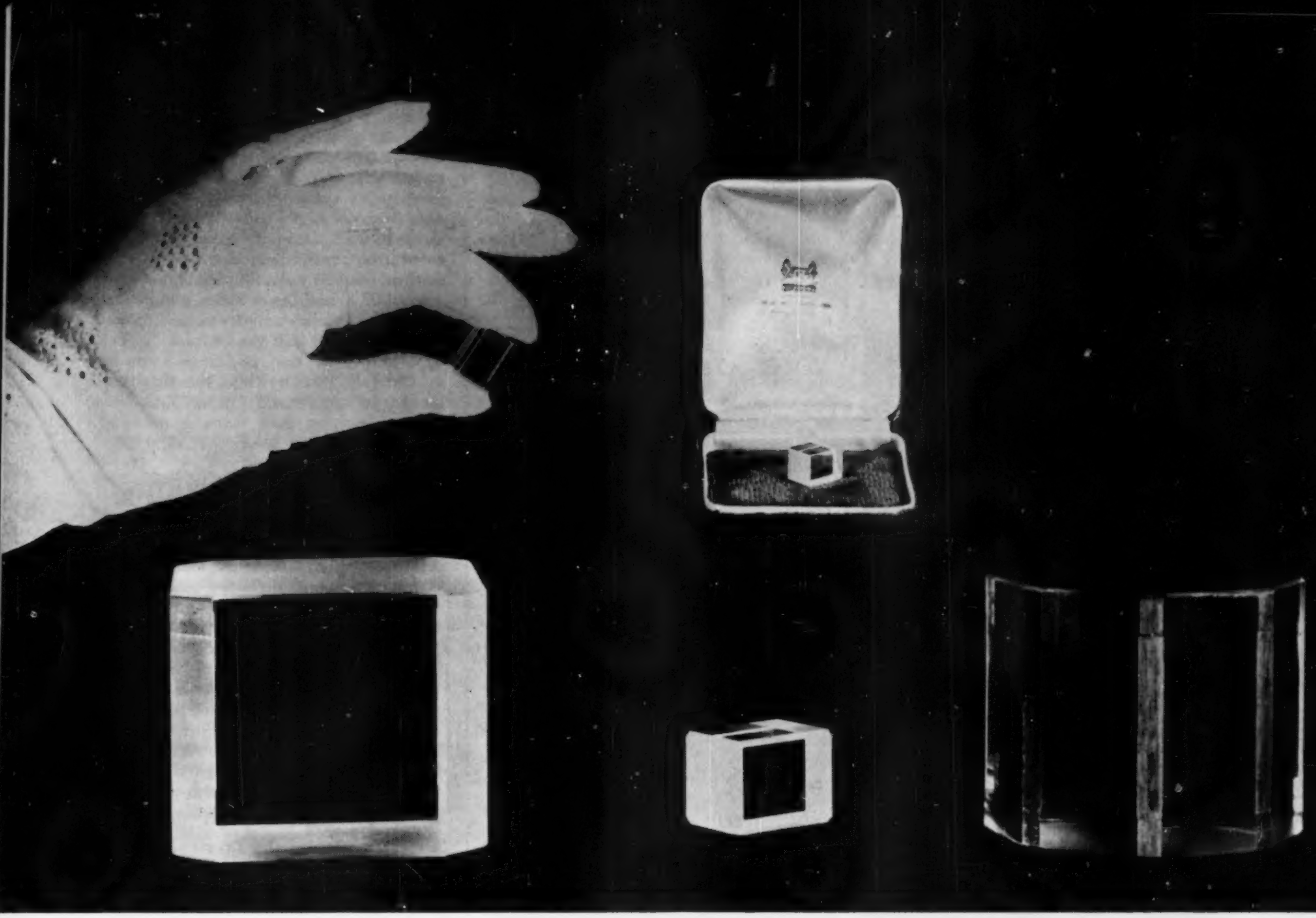
III. The Method of "Starved" Development of Aero Film: A sensitometric study has been made of "starved" development of films under laboratory conditions, in which the quantity of developer is sufficient to develop the weakly exposed parts but insufficient for the strongly exposed parts, so that the latter do not completely develop. Formulas are given for the starved-development method under laboratory conditions. It is shown that the method makes it possible to increase the film speed in comparison with the usual method of development (at a single value of gamma); to increase photographic latitudes; and to increase the maximum density. Some growth in fog and an increase in the time of development are mentioned as disadvantages of the method—S. C. G. (Translated from *Tekh. Kino i Televideniya.*)

CAMERAS AND EQUIPMENT (Except High-Speed)

Electricity Supply Conditions for Spotlights During Shooting of Motion-Picture Films (in Russian), S. Kh. Nazarov, *Tekh. Kino i Televideniya, 4:* 52–57, Nov. 1960.

New Techniques in the Mosfilm Motion-Picture Studios in 1960 (in Russian), G. I. Khazanov, *Tekh. Kino i Televideniya, 4:* 66–69, Nov. 1960.

The experiences of the Mosfilm studio during the production of films by new techniques, particularly wide-screen cinematography with 70mm film, are discussed. —S.C.G.



A Study of, and Methods for Reducing the Noise of Motion-Picture Cameras (in Russian), L. I. Zaets, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 101–109, No. 34, 1960; *Tekh. Kino i Televideniya, 4:* 90, Nov. 1960.

Results are given of an experimental study of the noises from the [Russian] 2KSS motion-picture camera, and the sound-insulating properties of certain materials.

A description is given of two cinematic layouts for the camera mechanism, and it is shown that, notwithstanding the increase in the number of pairs of toothed wheels, a considerable reduction in camera noise level has been attained. Methods are described for fixing the mechanism and camera parts to the body, to ensure a reduction in the level of vibrational noise. Results are given of a study of the sound-insulating properties of one type of synthetic resin which has been recommended for making motion-picture camera boxes.—S.C.G. (Translated from *Tekh. Kino i Televideniya.*)

New Constructions in 8mm Amateur Motion-Picture Cameras (in Russian), V. G. Pell', *Tekh. Kino i Televideniya, 4:* 80–84, Nov. 1960.

A number of 8mm motion-picture cameras of European production are reviewed.—S.C.G.

COLOR PHOTOGRAPHY AND COLOR DEVELOPMENT

The Law of the Change of Rate of Color Development with Change in the Properties and Increase in the Concentration of Nondiffusing Color Couplers in a Photographic Material. II. The Change of Contrast Coefficient with Small Concentrations of Coupler (in Russian), V. I. Uspenskii and N. I. Rodionova, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 5:* 419–423, No. 6, Nov.–Dec. 1960.

Part I (*Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 4: 285–288, No. 4, July–Aug. 1959*) confirmed a linear relationship between gamma of a developed color-image and log concentration for a number of color couplers over a concentration range of 2 to 16 g/liter of emulsion. However, the experimental points did not lie well on the straight lines at low concentrations. Experiments now carried out by developing emulsion coatings containing low concentrations of the same couplers (derivatives of benzoylacetic acid, of pyrazol-5-one, and of 1, 2-hydroxynaphthoic acid) have shown that, at low concentrations (up to $\sim$4 g/liter), the relation is not logarithmic, gamma being directly proportional to the concentration of coupler. Because of the differences in behavior of couplers with a high activity compared with those with medium and low activities, it is necessary to be careful in choosing the concentrations for comparative tests.—S.C.G.

Primary Color Separation and Inter-Image Effects in the Development of Color Photographic Materials (in Russian), D. K. Balabukha and N. V. Makova, *Tekh. Kino. i Televideniya, 4:* 31–40, Dec. 1960.

The term "primary color separation" means the initial analysis into the three-color records carried out at the moment of exposure to the subject. Its efficiency cannot be properly evaluated without reference to the final synthesis. A mathematical analysis of color separation by Nyuberg (*Uspekhi Nauch. Fotografii, 2:* 134, 1954) is outlined and the derivation of his color-separation zones is explained. The method is then used to show that the inter-image effects of a multilayer color negative are equivalent to automatic color masking. It then appears that the efficiency of color separation of the multilayer negative material is greater when the final color image is synthesized by an imbibition positive process than when a multilayer positive material is used.—S.C.G.

FILM AND ITS PROPERTIES

New Films, DS-5 and TsP-7, Under Production Conditions (in Russian), *Tekh. Kino i Televideniya, 4:* 49–56, Oct. 1960.

Two new films, the DS-5 color-negative film with masking couplers and the TsP-7 color-positive film, have recently been produced by NIKFI and the Shostka chemical factory for the Soviet motion-picture industry. Practical trials have been carried out by the processing laboratories of the A. P. Dovzhenko Film Studios in Kiev, and the results are now presented. A few modifications of the original processing instructions from NIKFI seem to be called for under the conditions of testing.—S.C.G.

Determination of the Practical Speed of Reversibly Processed Black-and-White Films (in Russian), B. N. Modestov, *Tekh. Kino i Televideniya, 4:* 47–52, Nov. 1960.

The "practical" speed of films for reversal processing was determined by a method based on the visual choice of the best frame in a series of exposures to natural objects, and on calculation from the known conditions of exposure. The films tested were the reversal-film type, OKP-1, and several negative and positive films, all Soviet-produced, subjected to reversal processing; their sensitometric properties, measured in this way, are tabulated. The speed of OKP-1 Film can vary by a factor of 1.6, according to the conditions of exposure and processing. Negative films had speeds similar to that of OKP-1, or higher, while positive films were considerably slower.—S.C.G.

FILM PROCESSING (Apparatus and Chemicals)

Spray-Processing of Motion-Picture Film (in Russian), L. B. Blyumberg, V. G. Ivanova, L. I. Karpova, T. A. Novatskaya and G. G. Novikova, *Tekh. Kino i Televideniya, 4:* 14–19, Nov. 1960.

Experiments have been carried out on the spray processing of motion-picture films, a technique already in use outside Russia. Successful processing of the positive film can be carried out completely in 2 to 2.5 min, and of negative film in 9 to 10 min, with good picture quality and keeping properties.—S.C.G.

A Study of the Processing of Reversal Film for Traveling Mattes (in Russian), A. M. Churaeva, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 95–102, No. 35,

1960; *Tekh. Kino i Televideniya, 4:* 92, Nov. 1960.

A description and results are given of an experimental study to find the relation between the change in concentration in potassium bromide in the matte developer and the solubility of silver bromide. An explanation is given of the use of 15 g potassium bromide per liter of developer prescribed for processing reversal film used for composite films.—S.C.G. (Translated from *Tekh. Kino i Televideniya.*)

HIGH-SPEED PHOTOGRAPHY AND INSTRUMENTATION

Variable-Contrast Optical Projector, T. Suzuki and G. Shinoda, *Technol. Repts. Osaka Univ., 10:* 693–704, Oct. 1960.

An optical projector having very high sensitivity for detecting fine structures in objects has been developed. The contrasts of images can be varied according to their purpose by changing the different transmittance masks in front of the light source. When the highest contrast was used, fine structures, which could hardly be seen with ordinary projectors, were easily detected. When medium contrast was used, the fine structures disappeared from images, and noiseless images, under certain conditions, were obtained from optically noisy objects. (Authors' Abstract.)

Cinematography of Motion of a Body in Two Media (in Russian), V. I. Rybakov, A. G. Nikolaenko and O. A. Sokolov, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 5:* 424–432, No. 6, Nov.–Dec. 1960.

The high-speed cinematography of a body passing from one medium into another (e.g., from air into water, or vice versa), or moving along the boundary, presents particular difficulties in lighting because of the differences in the absorbing and scattering properties of the two media and differences of scale caused by differences in refractive index. These points are discussed in some detail and lighting schemes for some special cases are described.—S.C.G.

The Measurement of the Velocity of Luminescent Jets (in Russian), G. Strelkov and O. I. Yas'ko, *Inzhener.-Fiz. Zhur., 3:* 93–95, No. 5, 1960; *Referat. Zhur., Fiz.,* Abstract No. 34445, Dec. 1960.

The velocity of high-temperature jets has been determined by the method of streak photography. (Translated from *Referat. Zhur., Fiz.*)

New Apparatus for High-Speed Photography and Cinematography (in Russian), A. A. Sakharov, *Tekh. Kino. i Televideniya, 4:* 63–68, Dec. 1960.

The CR-16 sensitometer (made by the State Optical Institute) covers a wide spectral range and gives characteristics of photographic materials with exposures of from 6×10^{-2} down to 10^{-7} sec. The temperature of the photographic material can be varied from −150 to +60 C.

A prototype high-speed camera with discontinuous film transport (also made by the State Optical Institute) works at up to 1000 frames/sec. It uses 35mm film, but the principle should be successful with other formats. The film is braked at a high frequency by means of a pulsating pressure element at the gate, the slack film being

allowed to form a loop before the gate at each stoppage. The perforations are engaged only by teeth on continuously rotating sprocket drums.

Three "waiting" cameras, i.e., cameras in which the mechanism is allowed to operate at full speed while waiting for the event which trips the shutter, are described. They are the SSKS-3 (made by the Leningrad Institute of Fine Mechanics and Optics), a multiple-objective, rotating-beam camera taking up to 800 frames at a speed of 500,000 frames/sec; the ZhLV camera (made by the Institute of Physical Chemistry of the Academy of Sciences), which achieves speeds of 20,000–3,000,000 frames/sec by means of a rotating-mirror system; and the RKS-11 (made by the Leningrad Institute of Motion Picture Engineers), a moving-grid camera operating at 1000-100,000 frames/sec.

Lenticular grids made by NIKFI are claimed to pass more light than those used in the Sultanoff camera (U.S.A.) and to have a finer structure than the Courtney-Pratt (England) camera. The characteristics of the grids are tabulated. Other apparatus very briefly described includes viewing apparatus for analyzing high-speed films.—S.C.G.

New Soviet High-Speed Equipment, A. Sakharov, *Sci. Film, 1:* 12–13, No. 5, Feb. 1961.

Owing to the extensive use of high-speed photography in science, engineering and the national economy, special equipment and instruments are being designed and produced. They include instruments for special sensitometric testing of photographic material and equipment for demonstration and analysis of film records. This paper deals with instruments made during 1959 and 1960. (Author's Abstract.)

PRINTING AND OPTICS

The 23KTK-1 Contact-Film Printer (in Russian), N. D. Bernshteĭn, I. S. Golod, S. Ya. Golosinskiĭ, A. N. Zaĭtsev, E. M. Pogorelov, S. V. Smirnov, M. G. Shamshteĭn and A. G. Shmakov, *Tekh. Kino i Televideniya, 4:* 10–19, Oct. 1960.

An outline is given of the basic technical characteristics of the new 23KTK-1 film printer for the accurate printing of pictures on 35mm color film. It has been developed by the Central Constructional Bureau of the Ministry of Culture of the U.S.S.R. in collaboration with NIKFI, and has been put into production by the Lenkinap factory.—S.C.G.

PROJECTION LIGHT SOURCES AND SCREENS

Soviet Motion-Picture Technology of Tomorrow (in Russian), V. G. Komar, *Druzh. nar.*, No. 4, pp. 189–91, Apr. 1959.

Wide-screen motion-picture theaters exist at many places in Russia now; the Cinerama motion picture is in development and approximates the quality of the American Cinerama. In the next two or three years, 20 large motion-picture theaters will be built in Soviet cities, of which one in Moscow will have a seating capacity of 6000, while others in Kiev, Leningrad, Moscow, Baku, Tashkent, Tbilis, Novosibirsk, Riga and other places will have seating capacities of 2500–4000. In their technical equipment they exceed not only the European, but also American motion-picture theaters. They will be equipped for projecting Cinerama, wide-screen and common films. A special ultrasonic apparatus for determining acoustics has been designed and used successfully in large theaters and auditoriums in Moscow. It is planned that 75mm instead of 35mm film will be used in the future, even for ordinary motion pictures, because it gives a considerably better quality of the image. A brief statement on how the Circorama motion picture was introduced to the United States and a comment that the Soviet Circorama is in the process of development close the article.

A Light Source with Xenon Lamp (in Russian), *Tekh. Kino i Televideniya, 4:* 48, Oct. 1960.

A brief note and diagram give a few details of a 1-kw, d-c xenon lamp source which is being made at a Rostov-on-Don factory to a NIKFI design. It is intended for use with Soviet-made type KPT motion-picture projectors.—S.C.G.

The Exhibition of the New Types of Motion Picture (in Russian), V. G. Komar, *Tekh. Kino i Televideniya, 4:* 75–80, Oct. 1960.

Developments in the exhibition of wide-screen and panoramic motion pictures in the United States, the Federal German Republic, and Holland are reviewed from material gathered by foreign missions. Special attention is paid to the MGM-65 (Panavision), Cinemiracle, and Aromarama systems.—S.C.G.

The Right Type of Educational Motion-Picture Projector (in Russian), M. Dukovnaya, *Tekh. Kino i Televideniya, 4:* 71–72, Oct. 1960.

It is stated that no narrow-gauge projector really suitable for teaching purposes is available in the Soviet Union. The requirements of a suitable projector are discussed.—S.C.G.

An Illumination Engineering Study and a Method of Welding Plastic Motion-Picture Screens (in Russian), M. D. Borodin and K. I. Mel'nikov, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 5–23, No. 36, 1960; *Tekh. Kino i Televideniya, 4:* 87, Nov. 1960.

The results of the development of a method of high-frequency electrowelding of the sheets forming plastic screens, giving practically unnoticeable welds, are presented. The results of a study of the noticeability of the welds by the audience are given. It is concluded that the method gives very firm welds, unnoticeable on projection onto both diffusing and directional screens.—S.C.G.

The Narrow-Gauge Varioprojector (in Russian), *Tekh. Kino i Televideniya, 4:* 84, Nov. 1960.

The Hungarian-made Varioprojector is basically a 16mm projector, but with the

attachments provided it can be converted for the showing of wider-gauge films and film slides. A microscope system can be placed in front of the lens to give enlargements of detail. The projector is intended for scientific and educational purposes as well as for normal showings.—S.C.G.

Motion-Picture Projection with a Pulsed Capillary Lamp (in Russian), G. L. Irskii, *Tekh. Kino i Televideniya, 4:* 74–80, Nov. 1960.

The Philips SPP-800 pulsed lamp and the FP20S projector in which it is incorporated are described.—S.C.G.

Five Years of Soviet Wide-Screen Photography: Its Results and Problems (in Russian), Yu. A. Kalistratov, *Tekh. Kino i Televideniya, 4:* 6–13, Nov. 1960.

A survey is made of the present position of wide-screen cinematography in the Soviet Union, with tabulation of statistical data.—S.C.G.

New Forms of Cinematography and Their Future Possibilities (in Russian), S. M. Provornov, *Tekh. Kino i Televideniya, 4:* 1–6, Nov. 1960.

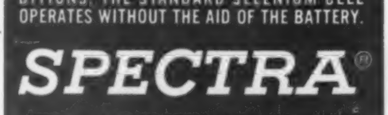
The different forms of wide-screen, wide-film, and panoramic cinematography are compared from the points of view of the changes in equipment required in installing them, and their effectiveness in giving the spectator, irrespective of his position in the auditorium, a sense of participation. The author believes that the different systems are suitable for different types of subject, and that none will supplant the normal type of cinematography as a mass medium. It follows from this that most new cinemas being built in the Soviet Union should be of the normal type, with provision for wide-screen shows. The largest theaters (seating several thousand) should be provided with equipment for all types, including panoramic. There will still be a call, for some time to come, for cinemas showing normal films only. Western practice has shown that stereophonic sound is not essential for the average wide-screen film, and installation of wide-screen systems should not be delayed because of the difficulties in installing a multichannel sound system.—S.C.G.

Objective Distortions of Motion-Picture Images with Vertical and Horizontal Projection Angles. *I. The Plane Cine Screen* (in Russian), E. M. Goldovskiĭ and S. S. Ryshkov, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 5:* 439–445, No. 6, Nov.–Dec. 1960.

Objective distortions of motion-picture images are those introduced by the geometry of projection as distinct from subjective distortions which are due to the position of the viewer. A mathematical analysis is made of the dependence of such distortions on the angle of projection in relation to a flat screen.—S.C.G.

Calculation of the Light Flux of a Motion-Picture Projector with the DKsSh-1000 Xenon Lamp (in Russian), O. L. Anisimov, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 24–50, No. 36, 1960; *Tekh. Kino i Televideniya, 4:* 87–88, Nov. 1960.

Work has been carried out on the setting up of theoretical limits to the maximum light-flux obtainable from a 35mm motion-



picture projector with a 1-kw, d-c xenon lamp. The following have been worked out for different angles of viewing: the shape of the radiating discharge of the xenon lamp; curves for the transverse-brightness distribution over the discharge; and curves of equal luminance ("isomeganits") in the plane of the projector gate. Calculations for the luminance at ten points of the gate are given.—S.C.G. (Translated from *Tekh. Kino i Televideniya.*)

Some Characteristics of an Arc with Air Blast (in Russian), V. V. Piskunov, *Trudy Vsesoyuz. Nauch.-Issled. Kinofotoinst.*, pp. 51–63, No. 36, 1960; *Tekh. Kino i Televideniya, 4:* 88, Nov. 1960.

A new form of carbon arc is discussed, which shows a number of advantages in comparison with the usual forms of high-intensity arc. It will be very important in the design of powerful motion-picture projectors for service in auditoriums seating 6000 or more. The following sections are included: the characteristics of an arc with air blast; and the operation of an arc with an air blast in the optical system.—S.C.G. (Translated from *Tekh. Kino i Televideniya.*)

Dimensions for the Soviet Circular Motion-Picture Panorama System (in Russian), E. N. Goldovskiĭ, *Tekh. Kino. i Televideniya, 4:* 21–30, Dec. 1960.

In working out the Soviet system of circular motion-picture panorama, the problem arose of building a theater giving greater possibilities for exhibition of films than in the American Circarama system, it being necessary to avoid the faults in the latter arising from the incomplete solution of the separate technical problems.

In addition, it was considered necessary to increase the capacity of the first theater for circular panorama at the Exhibition of Achievements of the National Economy of the U.S.S.R. to at least 300. The conditions for obtaining optimum presentation, both from the point of view of optimum viewing by the audience and convenience of placing the cameras, are discussed.—S.C.G.

Calculating the Required Level and Variation in Motion-Picture Screen Luminance (in Russian), M. V. Tsivkin, *Tekh. Kino. i Televideniya, 4:* 41–48, Dec. 1960.

A method is given for solving the problem of what should be the level and variation in the luminance of a motion-picture screen in order to ensure the required level and variation in its brightness for all, or as many as possible, of the viewers. As an example, a numerical solution of this problem is applied to a wide-screen installation with the NIKFI lattice screen. A method of calculation is shown for examining the brightness of the screen for critical points of observation.—S.C.G. (Translation of Author's Abstract.)

SOUND RECORDING AND REPRODUCTION

The Problem of the Number of Channels and the Quality of Sound on Stereophonic Films (in Russian), I. Aleksander, Ya. Butovskii and E. Yudin, *Tekh. Kino i Televideniya, 4:* 61–67, Oct. 1960.

Nine Channels on Six Soundtracks (in Russian), G. Klimenko, *Tekh. Kino i Televideniya, 4:* 67–68, Oct. 1960.

New Equipment for Sound Recording and Film Processing in Film Production (in Russian), I. B. Gordiĭchuk, *Tekh. Kino i Televideniya, 4:* 58–64, Nov. 1960.

A number of new types of apparatus produced during the past year in the U.S.S.R. are briefly described. They include a number of soundtrack printers, especially for the preparation of multi-channel records for stereophonic sound used with wide-screen and panoramic films. Processing machines (one for 70mm film and one for 35mm and 16mm) and a printer for panoramic films have also been made.—S.C.G.

Sound for Narrow-Gauge Motion-Picture Films (in Russian), L. I. Burdakhin and V. S. Drabenyastyĭ, *Tekh. Kino. i Televideniya, 4:* 72–74, Dec. 1960.

A simple method has been elaborated for providing 16mm sound films for scientific purposes. A standard 6.5mm magnetic tape is cut into three lengthwise strips and one of the narrow strips is cemented onto the film. The Russian 16mm projector, the Ukrain (PP16-3), has been adapted to carry out this operation.

The projector, which is provided with a sound head for reproduction, has been adapted so that it can also be used for recording the sound track in synchronism with the film.—S.C.G.

TELEVISION

New Motion-Picture Practice in Television (in Russian), G. O. Zhizhenevskii and T. S. Beletskaya, *Tekh. Kino i Televideniya, 4:* 8–9, Oct. 1960.

A brief survey is made of the development work on motion-picture apparatus and techniques for use in television, now being carried out by various institutes and instrument factories in the Soviet Union as part of recent plans for the development of the industry.—S.C.G.

A Telecine Machine for Color Television with a Three-Vidicon Camera (in Russian), V. A. Buldakov, G. V. Zhirnova, S. V. Novakovskii, V. A. Petropavlovskii and A. I. Razin, *Tekh. Kino i Televideniya, 4:* 36–40, Nov. 1960.

The telecine machine described consists of a standard Soviet SKP-34 projector with a television camera containing a beam-splitting optical system and three vidicon tubes to give the three color channels. The projector is not synchronized with the vidicons. A table sets out a comparison of this machine and the flying-spot system for a large number of factors.—S.C.G.

VIDEO TAPE

The Theory of Telecine Transducers (in Russian), N. K. Ignat'ev, *Tekh. Kino i Televideniya, 4:* 20–26, Nov. 1960.

The term "telecine transducer" covers both machines for transmitting motion-picture films and machines for recording television programs on film. Both types are discussed. In addition, frame-frequency changers are dealt with. A mathematical theory of the performance of these machines, from the point of view of preservation of the quality of the signal, is developed.—S.C.G.

books reviewed

Photographic Chemistry, Vol. II

By Pierre Glafkides. Tr. from the French by Keith M. Hornsby. Published (1960) by Fountain Press, London. U. S. Publisher, MacMillan Co., 60 Fifth Ave., New York 11. 996 pp. Charts, diagrams and tables. 6 by 9¾-in. Price $21.00.

This volume completes the British translation of Glafkides' 2nd French Edition of his textbook. Unfortunately I must repeat my comments on the first volume (see p. 792, *Journal*, Nov. 1959) to warn the prospective user that while this text fills a definite need, it is not very reliable. A careful reading shows that it contains the same kinds of errors as Vol. I, often due to careless reading of references and to attempts to condense bulky papers where statements, which were correct in context, are wrong or at least misleading, as shown here. An experienced user can often spot these points but only in the areas where he is himself knowledgeable; this must lead him to doubt the accuracy of areas which are not in his own field of experience, even though of great importance to him.

Volume II covers Color Reproduction and Color Sensitization in which the Author includes light sources, color development and many other ways for the production of colored images. He concludes with a 30-page "Summary of Fundamental Chemical Laws" which might well have been omitted since it is so condensed it is of little use to the beginner and of value only as a refresher to one who has had this material in a more complete form. There are also some complementary notes, probably mostly contributed by the translator; these are quite helpful.

The section on sensitizing dyes is quite extensive and a dyestuff chemist to whom it was referred found few inaccuracies

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compared to the rest of the book, perhaps because more details are given here and because detailed survey articles are available in the literature on which this section is based.

The actual inaccuracies in these volumes are so frequent it is of little value to cite them individually, but in total they make it impossible to recommend the volumes to the student or beginner in photographic science or engineering, for whom such a book is needed, since fundamental points must be cross-checked with more reliable sources before use. For example, although there are occasional films with higher sensitivity to artificial light than to daylight, the Author on page 528 implies that most pan films have such a response, which is contradicted by his Figure 84 which he shows in support, and by manufacturers' instruction sheets packed with all sensitized materials. This implication is more misleading in view of his statement earlier, on page 507, that light from a carbon arc and daylight are less efficient than "electric" (meaning tungsten) light: "the densities obtained with panchromatic emulsions are lower than when electric light is used." The whole treatment is so abridged that details of what special conditions might give such results are missing. The reader would assume that with equal exposure meter readings, the tungsten light is photographically stronger.

The high price ($42.00 for both volumes) makes this text too expensive as a secondary reference, which is a pity as much of the data collected here is otherwise widely scattered in the international literature. This, of course, illustrates the fact that the whole field of photography has now grown to a size where even a two-volume treatment cannot adequately cover it; even the large book of Mees does not try this, but takes the other approach of giving an annotated bibliography, without attempting an unsupported presentation to be used alone. — *Thomas T. Hill*, Photographic Products, Atlantic Gelatin, Woburn, Mass.

Leica Manual and Data Book

By Willard D. Morgan; Associate Editors, John S. Carroll and Dorothy S. Gelatt. Published (1961) by Morgan and Morgan, Inc., 101 Park Ave., New York 17; (and The Fountain Press, London). 456 pp. incl. index. Diagrams, halftones and color plates. 5¾ by 8½-in. Price $6.95.

This perennial manual first appeared in 1935, and its last previous edition was in 1958. It includes data on the latest Leica products, and on the new Kodachrome II. Although the manual is especially designed to cover the use of Leica equipment, a large proportion of the information is applicable to all 35mm photography. The general subjects covered are the details of the Leica cameras and lenses, and also of all the Leica accessories (from filters, special film magazines, and developing tanks, to auxiliary focusing devices for extreme close-up, and also for telephoto shots), film and exposure data and processing, black-and-white and color taking techniques, and copying, press, industrial and medical photography. The instructions on good lighting are interesting; this is often the despair of amateurs, all but the most sophisticated. The discussions on the intricacies of flash photography with a focal-plane shutter are not overly clear — perhaps a good table of slit transit times (also otherwise useful) would have been helpful. The jacket boast "*All* about 35mm photography" is not of course met, but a really large amount of information is packed into this book. — *Pierre Mertz*, 66 Leamington St., Lido, Long Beach, N. Y.

Symposium: Visual Problems of Color

Proceeding of a Symposium on the Visual Problems of Color held September, 1957, at the National Physical Laboratory, England. Published (1961, first American edition) by Chemical Publishing Co., 212 Fifth Ave., New York 10. (First published in 1958 by Her Britannic Majesty's Stationery Office on behalf of the National Physical Laboratory.)

Vol. I, 396 pp. illus. graphs, diagrams. 8½ by 6 in. Price $8.50.
Vol. II, 368 pp. illus. graphs, diagrams. 8½ by 6 in. Price $8.50.

In September of 1957 there was held at Teddington a symposium on the visual problems of color. The proceedings were published in England in 1958; but for some unstated reason the American edition has not been published until 1961. The delay has permitted the inclusion of an additional paper — E. H. Land's 1959 contribution to the National Academy of Sciences on two-primary color projection and viewing.

In the organization of the symposium 10 or 12 papers each came from the United Kingdom, the United States and Russia. One paper each came from France, Canada, Italy, Spain, Holland, Venezuela, Sweden and Finland.

One current subject of central interest has been the progress in the preparation for the revision of the CIE standard observer and color-mixture functions. There is a report by Deane B. Judd on the progress of field trials for this. Unfortunately they ran into calibration troubles and a formal paper was not presented, but only an oral statement which is summarized here. One field report, by K. L. Kelly, was completed and is reproduced. Some further material was published elsewhere later, but is not included here. A number of other contributions at the symposium deal with problems of color metrics, and therefore are close to the revision, though they were not officially part of it.

One might say, with regard to the revision, that the beautiful simplicity and linearity of the CIE system seems doomed to disappear with the use of the wider test spot and higher test luminance. It is becoming increasingly clear that such an idealized system is only an asymptotic condition holding for the more primitive testing conditions. The best one can hope for the revision is that it will not run into too many complications, and still remain accurate.

The first session of the symposium was devoted to a commemoration of Selig

Hecht. It and the next session dealt with retinal pigments and their chemistry. Other sessions dealt with time factors and eye movements in relation to color perception; electrophysiology of vision; and theories of color perception and adaptation, and of perceptions of brightness.

The book is offset-printed from typewritten original. While neatly done, it is bulkier than it would be with conventional type. In volume II, the second half of the table of contents (after page 131) has been inexcusably forgotten.

It is interesting to have so much material on color vision brought together compactly, because there are so many diverse efforts in this field. Much of this will eventually have its effect on color technology. It is of interest to the color worker who is prepared to read detailed material.—*Pierre Mertz*, 66 Leamington St., Lido, Long Beach, L.I., N.Y.

Bulletin on Technical Control for the Cinema, and on the Bureau of Standardization for the Cinema Industry (in French)

Published (1961) by the High Technical Commission of the French Cinema, 92 Ave. des Champs Elysees, Paris 8e. 52 pp. with illus., 8¼ by 11¾ in. Apply to publisher.

Last year the High Technical Commission of the French Cinema organized an international colloquium on cinematographic techniques, and its bulletin published the proceedings of that colloquium. The present bulletin, more modest in size, outlines the organization of the Commission and its many activities.

The organization is quite intricate, but two outstanding functions are the sponsoring of a Technical Control for the cinema, and of a Bureau of Standardization for the cinema industry (the latter having some connection with the French Standardization Association). These sponsored groups have a number of committees, and issue documents of good engineering practice and standardization, test films and test charts. Lists of all these (34 test films, 5 charts, over 75 standards) appear in the bulletin. It also includes information on other activities of the Commission.—*Pierre Mertz*, 66 Leamington St., Lido, Long Beach, L.I., N.Y.

Posing for the Camera

By Harriett Shepard and Lenore Meyer. Published (1960) by Hastings House Publishers, 151 E. 50 St., New York 22. 6¾ by 9¾ in. 184 pp. profusely illustrated. Price $6.95.

Written by a professional photographer (Miss Shepard) and a teacher of photographic modeling (Miss Meyer), the book is intended primarily as a guide for professional models, but is also intended for the instruction and interest of photographers and directors. Numerous diagrams illustrate the authors' discussions of the photographic potential of the human face and body. The authors' aim as set forth in the Foreword is to "organize thought on the part of photographers, directors and models" in respect to both the mechanics of posing and its more creative aspects.

Books, Booklets, Brochures

Applied Optics (first issue scheduled for January 1962), a bimonthly publication of the Optical Society of America, 1155 Sixteenth St., N.W., Washington 6, D.C., has an annual subscription rate (incorrectly quoted on p. 480 of the June 1961 *Journal* as the prepublication rate) of $6.00 for OSA members and $10 for nonmembers. The prepublication rate applies only to three-year subscriptions and is quoted at $15 for OSA members and $25 for nonmembers.

Three new publications of the International Electrotechnical Commission (IEC) have been announced. IEC Publication 123 contains recommendations for general purpose sound level meters, including technical characteristics, microphone characteristics and calibration and checking of the meter. It is priced at $3.20.

IEC Publication 91 contains recommendations for frequency-modulation broadcast transmissions and is available in a Russian/English translation. It is priced at $6. Publication 48 covers rules for electric traction motors and is priced at $3.20. These publications are available from American Standards Association, Dept. P 236, 10 East 40 St., New York 16.

Three recently published electronics books of practical value both to students and technical workers are: (1) *101 Key Troubleshooting Waveforms for Sync Circuits* by Robert G. Middleton (Vol. IV in a series on waveforms). This book uses a waveform analysis approach, showing the appearance of normal waveforms at various key check points in a TV receiver as compared to abnormal waveforms, to identify the components causing specific types of abnormalities. The book is priced at $2.00. (2) *Tube Location Guide*, Vol. 11, compiled by the publishers, includes 70 diagrams showing the locations and functions of all tubes in 1961 TV receivers. It is priced at $1.25. (3) *Oscillator Circuits* by Thomas M. Adams has four-color diagrams to illustrate clearly stated explanations of what happens in nine basic oscillator circuits. The book is priced at $2.95 and is planned as Vol. I in a series on Basic Electronics. These three books are published by Howard W. Sams & Co., 1720 E. 38 St., Indianapolis 6, Ind.

Colburn Comments on Editing is the second booklet in a series compiled by Geo. W. Colburn Laboratory, Inc., 164 N. Wacker Drive, Chicago 6, Ill., for the benefit of industrial firms and other organizations engaged in 16mm production. This booklet contains a number of attractive and instructive illustrations and is clearly and concisely written to explain the essentials of setting up an in-plant editing department. Basic equipment is discussed in terms of economy and efficiency. The many preliminary steps in editing are carefully outlined and clear explanations are given for the methods used to achieve desired results. The booklet is available without charge from the company by requesting Booklet E-61.

A 12-page illustrated catalog, available without charge from Prestoseal Manufacturing Corp., 37-27 33d St., Long Island City 1, N.Y., describes the firm's line of Presto-Splicers designed for use with microfilm, paper tape, magnetic and motion-picture film. The catalog also describes the company's achievements since its founding in 1947.

Elementary Principles and Terminology of Sensitometry is a 22-page illustrated booklet published by The Gevaert Company of America, Inc., 321 W. 54 St., New York 19. Arranged in the form of a glossary, terms used in sensitometry are defined and explained. The terms are so clearly explained that the booklet can be read comfortably even by a reader unfamiliar with logarithms and equations. It is especially useful as an introduction to the scientific approach to photography. Information presented in the booklet ranges from theoretical principles to practical applications. Included are a number of charts and graphs showing the general characteristic curves of the emulsions and a table of common logarithms. The booklet is available without charge from the company by requesting Sensitometry #211.982.

Film and Television in the Service of Opera and Ballet and of Museums is No. 32 in a series of reports and papers on mass communications published by the United Nations Educational, Scientific and Cultural Organization (Unesco) at Place de Fontenoy, Paris 7, France. It is available in the United States from Unesco Publications Center, 801 Third Ave., New York 22, at a price of $1.00. The content of the 56-page booklet is divided into two parts: a report on the International Congress on Opera and Ballet in Television and Film, held in Salzburg; and quotations and conclusions from the Conference of Museum, Film and Television Experts held in Brussels.

Panoramic Progress, a 16-page illustrated brochure, describes the current status of panoramic aerial photography and compares modern methods and techniques with older and more conventional methods. Designed mainly for readers with scientific or technical interests, technical considerations and basic formulations relevant to panoramic aerial photography are presented. Equipments, including cameras and ground handling systems, are discussed and illustrated. The brochure is available without charge from Dept. 1-120, Itek Laboratories, a Division of Itek Corp., 10 Maquire Rd., Lexington 73, Mass.

Wollensak Pro-35 and Pro-70 Raptar Lenses for use on various types of vidicon cameras, including surveillance, data recordings, radar error measurement, theatrical and documentary, are described and illustrated in a four-page catalog available without charge from Wollensak Optical Co., Rochester 21, N. Y. Descriptions, lens diagrams and specifications are given. Data are also included for lenses for image-orthicon cameras.

News and Notes, published by the Optical Publishing Co., 165 Walker St., Lenox, Mass., made its first appearance in December, 1960, and the second issue, dated May, 1961, is now in print. The first issue contained a detailed discussion of high-altitude photography. The current

issue takes up the subject of "Recording and Rapid Display of Information," and suggests some interesting possible future uses of electrooptical devices. The pub.isher's offer: "In case you or any of your colleagues want to be placed on the mailing list for sporadic issues of *News and Notes*, we will honor your request."

A 38-page catalog describing U-L approved lighting control systems, including the SCR Dimmer introduced in 1958, has been issued by Kliegl Bros., 321 W. 50 St., New York 19. The control systems described in the catalog include those suitable for use in theaters, television studios, auditoriums, etc. The catalog also describes autotransformer dimmers, "Safpatch" and "Rotolector" cold patching systems, consoles, and programmers, together with technical descriptions and specifications. The catalog is available upon request to the firm.

A leaflet describing the ColorTran Cineking Light is available without charge from Natural Lighting Corp., 630 South Flower St., Burbank, Calif. The leaflet is illustrated and includes a performance chart for various types of lighting equipment, including the firm's Kicker and Super Kicker lights.

TV monitors for closed-circuit installations and broadcast station use are described in a series of four-page bulletins available from General Electric Communication Products Dept., P.O. Box 4197, Lynchburg, Va. The bulletins are designated as ECB 214 for broadcast; ECL 91 for military; and ECL 92 for industrial. The bulletins are illustrated and include descriptions and specifications for 14-, 17- and 21-in. monitors.

The Melcam Standards Laboratory, 179 Allyn St., Hartford 3, Conn., has issued a 4-page illustrated leaflet, available upon request, describing the laboratory's facilities, staff and services. The laboratory specializes in quality control of instrumentation for industry, production testing and instrument calibration, testing and repair.

A 62-page list of publications of the American Society for Testing Materials, 1916 Race St., Philadelphia 3, is available without charge. More than 300 items are listed, including descriptions for Symposiums, Manuals, Special Publications, Indexes, Compilation of Standards, Charts, Reference Photographs and Reports.

Optika i Spektroskopiya (Optics and Spectroscopy) is translated by the Optical Society of America and distributed without charge to its members under a three-year National Science Foundation grant which ends December 1961. In order not to discontinue the translation, OSA has set up a subscription rate schedule of $7.50 annual subscription for OSA members; $11.00 for members of other scientific societies, some 60 in all, described as the OiS club; and $15.00 for nonmembers and libraries. The English edition of *Optics and Spectroscopy* is published within three months of publication of the Russian edition. Additional information is available from The Assistant Secretary, OSA, 1155 Sixteenth St., N.W., Washington 6, D.C.

Indiana University's Audio-Visual Center has announced a 1961 supplement to its 1960 Catalog of Educational Motion Pictures. There are 650 new titles in the supplement making a total of more than 7000 films now available from the film library. Additional information is available from the Circulation Department, Audio-Visual Center, Indiana University, Bloomington, Ind.

A newly revised 160-page catalog (No. 62-A) issued by Films Incorporated, a subsidiary of Encyclopaedia Britannica Films, lists films from major Hollywood studios available in 16mm on a rental basis. The catalog includes a number of new releases from Paramount Studios, recently made available in 16mm. Films are grouped under 14 major headings and 89 subheadings. A capsule synopsis is given for each film along with symbols indicating suitability for certain groups, including films of special interest to children. The catalog is available upon request from interested individuals or groups from Films Incorporated, Sales Promotion Dept., 1150 Wilmette Ave., Wilmette, Ill.

A Technical Sales Coordination Office has been newly established by General Aniline and Film Corp., Binghamton, N.Y., under the direction of Ansco Division. The new office is located at 379 W. First St., Dayton, Ohio. Head of the new office is Robert B. Kushner.

A 2-page description by T. C. Hoad, *Motion Picture Magnetic Devices*, 9 Jackson Ave., Toronto 18, Ont., of the Dual Projector, which he developed to by-pass the "persistence of vision" phenomenon (which he describes as "a basic principle of the step projection system"), was distributed by Mr. Hoad at the 89th Convention. Additional copies are available from him upon request.

His description includes mention of an early experiment in which he attached two projectors with two-blade shutters 90° out of phase with each other, and used two identical films with the aim of keeping continuous illumination upon the screen. His next step was toward building a projector that would accomplish the same result with one film. His projector, which he has named "Dual Projector Mark 5," he states, "uses a single light source which covers both apertures. The light from both apertures passes through a single lens onto a prism and two surface reflectors which are stationary. The single shutter changes the light source from aperture to aperture as required. The film speed is 24 frames/sec, but the intermittent speed is only 12 exposures/sec on a dual intermittent. Each intermittent sprocket pulldown is two frames. The odd number frames are exposed on one aperture, the even number frames on the other aperture. The picture frames are dissolved into each other giving continuous screen illumination." He notes that it is "being protected by Canadian and American patents." He invites correspondence with "any person or engineer wishing to see the developments of this projector."

The second (December 1960) issue of *Cinema Studies:* The Journal of the Society for Film History Research (*Journal* p. 755, Oct. 1960) contains, among other articles, a selected bibliography of 22 books on the film published in Great Britain. It is noted that one of the major projects of the Society for Film History Research is the compilation of a complete bibliography of British books on the cinema. Editors of *Cinema Studies* are Neville March Hunnings and John Gillett. It is published at 1 Dane St., High Holburn, London WCI, England. It is presently published twice a year, but publication as a quarterly is planned for the near future. A bimonthly Newsletter is distributed to members. Annual membership dues of £ 1 include subscription to both publications. Correspondence, including answers to inquiries, is handled by Miss R. Heaword, Hon. Secretary, Society for Film History Research, 4 Hollybrake, Bull Lane, Chislehurst, Kent, England.

Teaching by Television (2d ed) (1961) is a joint publication of the Ford Foundation and the Fund for the Advancement of Education. The 88-page booklet presents a condensed report and evaluation of a nation-wide survey of educational television. The Preface points out that, while educational television is still "novel," the experiments described in the report involve more than 50 colleges and universities, 250 school systems, and, in the present academic year, more than 300,000 students and their teachers. It is estimated that about 7500 elementary and secondary schools are offering some instruction by television to about 3 million pupils. This estimated figure does not include pupils receiving television instruction over open-circuit commercial stations or by closed-circuit installations. These may number an additional 1½ million. In the closing section of the report, entitled "A Look Ahead," the report states, "The continuing activation of new educational television channels, the flexibility offered by video tape in recording, exchanging and scheduling courses, and the emergence of networks linking schools and colleges are all aspects of the broadening frontier of educational television. Finally, . . . airborne television will demonstrate the impact on the quality of teaching and learning of massive application of the medium." The report is available without charge from Ford Foundation, Office of Reports, 477 Madison Ave., New York 22.

Techniques of Editing Video Tape, a 30-page, 8 by 10-in. booklet published by the Magnetic Products Division of Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn., tells the story in pictures and text of the methods and devices used by video-tape editors to build shows from tapes, to locate splicing points and to create special effects. Clearly and briefly described are various methods of editing tape, such as direct cutting, double-system, frame-by-frame. Special effects devices, such as VideoScene, Zoom Keyer and Inter-Sync are described and their uses shown in picture series and accompanying text. The development of special editing methods for video tape (as

opposed to film) is outlined, and a brief description given of the double-system method presented by Oscar F. Wick in a paper published in the March 1960 *Journal* (pp. 164–166).

The "inside story" is told of how special effects devices and editing methods are used to create the illusion of reality in TV dramas and variety shows as well as the fantasy world of the TV commercial where "giant-size or midget-size individuals work with normal people or products; the announcer's image appears in the center of the product as he gives the commercial; products can be made to dance or dump. . . ."

This booklet is second in a series of informational booklets on video-tape recording. It is available upon request from Minnesota Mining and Manufacturing Co. Requests should be addressed to Dept. El-18.

Colburn Comments *on 8mm Magretic Sound* is a 10-page illustrated booklet which presents a great deal of information in a condensed but highly readable fashion. The history, techniques, and present and expected future applications of 8mm magnetic sound are discussed. The text forecasts no threat to 16mm production, but predicts that ". . . enough 8mm sound versions will be made to accommodate a vast, new film audience, never before reached." Written with admirable clarity and brevity, and well illustrated, it will be of particular interest to individuals and organizations exploring the possibilities of 8mm magnetic sound as a highly adaptable medium of communication in educational and commercial situations. The booklet is available without charge from Geo W. Colburn Laboratory, Inc., 164 N. Wacker Drive, Chicago 6.

Motion Picture and TV Service Directory, called "The Official East Coast Hand Guide," is a 36-page booklet which lists firms located on the East Coast offering equipments, products or services to the motion-picture and television industries. Newly published by Motion Picture Enterprises, Inc., Tarrytown 83 N.Y., subsequent issues will be published semiannually. Intended as a supplement to the MPE Wall Chart and Hand Directory, it is available on a combination subscription basis. Four issues of the Wall Chart and two issues of the Directory are available on yearly subscription, priced at $4.50. Single copies of the Wall Chart and Hand Directory are available at a combination price of $1.50.

Audio-Visual Equipment Directory, 7th ed. (revised), includes three new illustrated sections: Teaching Machines; Classroom Radios; and Instructional Television. More than a thousand different models of all types of audio-visual equipments are described and more than 700 of these are illustrated by photographs. The 294-page directory (8½ by 11 in., plastic ring binder) contains 23 sections, including the three new sections, and excluding Appendixes, Trade names, and a list of manufacturers' names and addresses (called "Where to Buy It"). Sections of the new Directory include descriptions of sound

motion-picture projectors; still picture projectors; micro-projectors; screens; projection stands; tape recorders; phonographs; language laboratory equipment; and reading and tachistoscopic devices. Editor of the Directory is James W. Hulfish, Jr., Director of Information, NAVA. It is available from National Audio-Visual Association, Inc., 1201 Spring St., Fairfax, Va. at a price of $4.75 (If payment accompanies the order, the price is $4.25.)

The Influence of the Cinema on Children and Adolescents: *An Annotated International Bibliography* published by Unesco, Place de Fontenoy, Paris 7e, France (also available from Unesco Publications Center, 801 Third Ave., New York 22, at a price of $1.50), lists and summarizes 491 publications, arranged in seven categories according to the approach made to the general subject. The work of writers from nearly 30 different countries is represented in this Bibliography. A brief evaluation of the material contained in the list of publications is presented in the Introduction. Although studies on the use of film as an educational aid were excluded, it was noted that "the growing interest in film education . . . production and distribution of special childrens' entertainment films and presentation of special programs, represents the most noticeable of the trends to be detected here." Another interesting finding noted in the Introduction concerned the controversial topic of juvenile delinquency. After explaining that in no other section were the opinions of writers so sharply contradictory, it was stated that ". . . on the evidence so far available, it is extremely difficult — indeed, virtually impossible — to establish that the cinema has a *direct* influence on juvenile delinquency."

The Industrial and Commercial Photographer is a new monthly journal launched in Great Britain (first issue, May 1961) for the special interests and information of professional photographers working in the various fields of industrial and commercial photography. Published at 319 High Holborn, London WCI, England, the Editor, G. H. Wilkinson, has been active in the industrial photography field for nearly 30 years. Contents of the first issue seemed to set a high standard of practical, informative articles by working professionals. Yearly subscription, available from the Subscription Department, 131 Great Suffolk St., London, SEI, England, is £1–10.

The UFPA Digest published by the University Film Producers Association is a newsletter containing items of special interest to UFPA members. It is presently published at the University of Oklahoma, and correspondence should be addressed to Charles N. Hockman, President, UFPA, Motion Picture Production, University of Oklahoma, Norman, Okla. The UFPA's official publication, *Journal of the University Film Producers Association*, is published quarterly at the Motion Picture Division, Dept. of Photography, 1885 Neil Ave., Ohio State University, Columbus 10, Ohio. The Editor is Robert W. Wagner.

The Photo-Lab-Index, a loose-leaf photographic reference book published by Morgan & Morgan Inc., Publishers, 101 Park Ave., New York 17, has had added to it Quarterly Supplement No. 87. The new supplement contains a complete data section on Polaroid. Data on Kodachrome II film and Revised DIN Film speeds are also included. The Lifetime Edition of the loose-leaf Index, which contains 1400 pages and 24 data sections, is priced at $19.95. Annual subscription to the Quarterly Supplements is $4.00.

Carbon Arc Spot and Flood Lamps; Stereoptican and Effect Machines; and Low-Intensity Projection Lamps are discussed in Bulletin No. 9 of the series published by National Carbon Co., Division of Union Carbide Corp., 270 Park Ave., New York 17. The Bulletins are designed to fit in a loose-leaf binder for convenient reference. Bulletin No. 9 is illustrated and tables supplementing the descriptions of the equipment are included.

Audio Visual Sales Promotion and Training Aids is a 2-page leaflet listing six accessory items for tape recorders and projectors. It is available without charge from Television Associates, Inc., East Barker Ave., Michigan City, Ind. The items are illustrated and the price is included in the description.

A Suggested Method for Cleaning Film Faster and More Effectively is an information sheet available without charge from Nicholson Products Co., 3403 Cahuenga Blvd., Los Angeles 28. A diagram with accompanying text explains the favored placement of rewind, cleaning paid, rollers, and proper motor and speed control to use with a power-driven cleaning assembly. Suggestions are included as to optimum speeds for both preprint and release footage.

A 12-page illustrated brochure, available without charge from Magnasync Corp., 5546 Satsuma Ave., North Hollywood, gives a brief history of the firm from its beginnings in 1953 as a three-man organization operating in a small plant to its present size. The present plant covers an area of 24,000 sq ft. Research activities are outlined and the firm's main products are illustrated.

Film Sprockets by LAVezzi is an 8-page illustrated catalog, describing in detail a complete line of sprockets of various sizes and designs. The catalog is available without charge from LaVezzi Machine Works, 4635 West Lake St., Chicago 44.

A brochure describing the 1961 model Tel-Animastand and Special Effects Stand is available from S.O.S. Cinema Supply Corp., 602 W. 52 St., New York 19. In addition to the basic stand, a full range of accessories is available. These include the Tel-Anima Sliding Cel Board, Shadow Box and Platen, Motorize Zoom and Automatic Follow Focus.

employment service

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Film Production Supervisor. 20 yrs experience in motion-picture and general photographic production. Presently in supervisory position in large inplant unit. Experienced in documentary, training and P.R. film productions. Do "A & B" cutting and sound recording. Hold Secret and "Q" Clearances. Resume upon request. Would consider Tech. Rep. position. Mo-pic, P.O. Box 9123, Montclair Station, Denver 20, Colo.

Credit and Office Manager Accountant. Efficient executive administrator, systems developer, personnel training and customer relation setups. Eight years film laboratory experience. Highest credentials. Résumé upon request. S. C. Robbins, 315 East 196 St., New York 58.

Position in engineering department of motion-picture laboratory or equipment manufacturer. Thirty years experience as supervisor in Engineering Department of Consolidated Film Ind., Fort Lee, N.J. Experience includes machine shop, construction and maintenance of printers, developing machines and other film equipment. Also assisted in design and development. Irving Fox, 3214 Kingsbridge Ave., Bronx 63, N.Y.

Free—$45,000 worth of 16mm cameras, lab and sound equipment, when under the supervision of a competent Audio-Visual Director. Over 20 yrs independent supplier of visuals and lab service to industry, government, education and TV. Desires to head and operate audio-visual service for one large responsible organization. Fial Films, 72 Lake Trail East, Wayne, N.J.

Positions Available

Assistant Chief Engineer. Seeking college graduate electronics engineer to assist Chief Engineer of commercial VHF television station in growing market. CBS affiliate; progressive management with long broadcast experience; good record of low personnel turnover. Majority of equipment RCA; two Ampex Videotape Recorders; maximum power; 1000-ft tower. Applicant should be capable of doing design and construction work, and should have some administrative ability. Salary commensurate with experience and ability. Replies treated in confidence. Write Chief Engineer, WLAC-TV, Nashville, Tenn.

Television Broadcast Technician. Seeking experienced, qualified television technician for maintenance and operation at commercial VHF station in growing market. CBS affiliate; progressive management with long broadcast experience. Station is well-equipped; maximum power; 1000-ft tower; two Ampex Videotape Recorders. Applicant must be ambitious, dependable, and have First-Class Phone License. Some formal schooling in electronics preferred. Salary commensurate with experience and ability. Replies treated in confidence. Write Chief Engineer, WLAC-TV, Nashville, Tenn.

Photographic Instrumentation Technicians. Opportunities for qualified technicians exist in the Pacific Island area assisting in the operation of the Pacific Missile Range. Requirements: High level of technical competence, good moral character, single, widowed, or divorced (no housing presently available for married applicants). Position offers good pay, overtime premium, broad technical experience, chance for advancement with progressive company. Technical areas open: Operation maintenance of Askania theodolites, LA-24 (ME-16), M-45 tracking telescopes and high speed sequential cameras. Electronics capability very desirable. Positions also available for Photo Laboratory Technicians. Wide experience in all phases desirable. Ample opportunity for cross training in related fields. Many fringe benefits. Please submit resume to: Vought Range Systems Div., P.O. Box 51, Naval Missile Center, Pt. Mugu, Calif. Attn: H. S. Weisbrod, Photo-Optics Supervisor.

Cameraman. Prefer man with considerable experience on Mitchell cameras. Midwest producer with fine reputation and financial standing wants man with ability and experience in lighting sets and operating camera on all kinds of interior and exterior photographic assignments. Job involves very little travel. Write giving full details of past and present employment and salary expected. Technisonic Studios, Inc., 1201 Brentwood Blvd., St. Louis 17, Mo.

Chemist-Photographic. Civil Service. Grade GS-11. Starting salary, $7560. In Photogrammetry Division, Photographic Service Branch. Involves establishing procedures in controlling quality of chemicals. Mail Form 57 (available at any post office) to Aeronautical Chart and Information Center, Attn. Mr. R. J. Gast, ACDPS, Second and Arsenal Sts., St. Louis 18, Mo.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Transactions. Ten volumes, Nos. 19 through 34. Write: William C. Kunzmann, 2992 West 14 St., Suite 2, Cleveland 13, Ohio.

Index 1936–1945; Mar.–Sept., Nov., Dec. 1947; Jan., Feb., Sept., Nov., Dec., Index Jan.–June 1948; Jan., Mar. & High-Speed Photography, Apr.-July, Index Jan.–June, Sept.–Dec., Index July–Dec. 1949; Jan.-Oct., Dec., Indexes Jan.–Dec. 1950; Jan.–Apr., June, July, Sept.–Dec., Indexes Jan.–Dec. 1951; Jan.–July, Index Jan.–June 1952; Jan.–Aug., Nov., Dec., Indexes Jan.–Dec. 1953; Jan.–June, Aug.–Dec., Indexes Jan.–Dec. 1954; Jan.–Dec. & Index 1955; Jan.–Dec. & Index 1956; Jan., Mar. 1957; Jan., Apr. 1958. Available as entire lot for $100. Camille Buyse, 1232 Chaussee de Wavre, Auderghem-Brussels 16, Belgium.

Jan. 1936 through Mar. 1957, except Mar. 1942 and Jan. 1945. Send offer to: R. S. Parris, 29 Charles St., Natick, Mass.

Assortment of Journals, from 1937 through 1950. Write: Alan Cook, South Londonderry, Vt.

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AVAILABLE AT SUBSTANTIAL SAVING one Eastman Kodak 31A Densitometer for black-and-white and color. Excellent condition. Box 840, 125 West 42 St., New York 36.

FOR SALE: New Bell & Howell 35mm Model D Printer with high intensity lamp house. This printer has been used only as a model for designing attachments; never in production. ($4,250.00, F.O.B Danville, Illinois) Electric Eye Equipment Div., Hurletron Inc., 1938 E. Fairchild St., Danville, Ill.

Complete set of Journals March 1937 through May 1954. Best offer. A. R. Ulmer, 69 Cresskill Ave., Dumont, N. J. DU 4-8656.

Complete set of Journals January 1949 through December 1960, inclusive, including high-speed, special issues, indexes, directories, etc., in excellent condition. For sale as entire lot only. Leslie Helhena, P. O. Box 643, Burbank, Calif.

Complete set of Journals from January 1934 through June 1960. Excellent condition. For sale only as a set. Write: Don Norwood, 1470 San Pasqual St., Pasadena, Calif.

Complete set of Transactions, except Nos. 6 and 9, and all Journals published to date, including indexes. All in good condition. Price $500. Also extra copies of Transactions Nos. 21, 31, 32. W. W. Hennessey, RFD #2, Pound Ridge, N. Y.

Complete set of Journals from May 1937 to June 1954, including special volumes and membership directories, excellent condition; also Mar., May 1934 and July 1935 issues. Write: Harry R. Lubcke, 2443 Creston Way, Hollywood 28, Calif. HO 9-3266.

Jan-Dec. 1950; Jan., Feb., Apr.-Dec. 1951; Jan-Mar. 1952. Also available are vols. 6 and 7 of The Television Society (British) covering the period Jan. 1950 through Sept. 1955. Write: Andrew N. McClellan, 65 Hillside Drive, Toronto 6, Ont., Canada.

Dec. 1946, Feb.-Dec. 1947, 1948–1955 complete. All copies in perfect condition; for sale as entire lot only. Write: Joseph W. MacDonald, 2414 Sullivant Ave., Columbus 4, Ohio.

Jan. 1947 to Dec. 1957 complete and in perfect condition. For sale only as a set. Write: Charles J. Marshall, 2816 Royalston Ave., Kettering 19, Ohio.

Wanted

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.

Transactions 6 and 9 ($15 each offered). W. W. Hennessey, RFD #2, Pound Ridge, N.Y.

Jan. 1938, Jan. 1949. (Many other issues are available for trade.) Dept. of Cinema, Univ. of Southern Calif., University Park, Los Angeles 7. Att: Herbert E. Farmer.

Mar. 1939, May 1940, July, Feb. 1942, July 1949. V. E. Patterson, 2 North 30th St., Phoenix, Ariz.

Résumés / Resumenes / Zusammenfassungen

The Society is grateful to the following authors for supplying translations: Adrian B. Ettlinger—*French, Spanish, German;* Arthur J. Miller and Robert Hartshorne—*French;* J. S. Courtney-Pratt—*French, Spanish German.* Translations contributed by Alex Quiroga, Pablo Tabernero and Lucas G. Lawrence are also gratefully acknowledged.

Les cinémas de Williamsburg Colonial en faveur d'un film de participation pour grand écran

Arthur L. Smith et Ben Schlanger [677]

Le plan d'ensemble du projet prévoyant une expérience de participation comme introduction à Williamsburg Colonial a été présenté dans une conférence illustrée en 1955. L'élaboration et l'achèvement du système sont maintenant présentés dans deux mémoires succints donnant d'abord un aperçu de l'historique et de la base pour la présentation du film, puis une description du système et des installations.

Considérations d'absorption d'énergie en projection cinématographique

Eric A. Yavitz [686]

Ce mémoire présente des données sur les caractéristiques d'absorption d'énergie des films mis en circulation en couleur et en blanc-et-noir. L'auteur donne des calculs sur l'énergie relative absorbée par ces films quand ils sont projetés avec un arc à charbon de haute intensité en association avec un réflecteur argenté ou dichroïque. Il compare les résultats et en indique la portée et les implications. L'article examine la distribution spectrale de l'énergie incidente et sa relation étroite avec les résultats obtenus avec les films en couleur.

Système de contrôle utilisant un ordinateur pour la transmission des programmes de CBS-KNXT

Adrian B. Ettlinger [691]

Dans les nouveaux studios de la station de télévision de CBS-KNXT à Hollywood, Californie, un ordinateur spécial développé par TRW Computers Co. est utilisé pour le contrôle de commutation successive entre les divers parts du programme. L'automatation des fonctions de commutation pendant l'interruption contrôlée du programme—c'est-à-dire, pendant les périodes de "rush"—permet à l'opérateur de concentrer son attention principalement sur la préservation de la qualité de l'image et du son. L'utilisation d'un ordinateur a produit un système de contrôle très adaptable permettant un grand nombre d'opérations très variées. Suivant, l'on trouvera pas seulement une description détaillée de la station de télévision de KNXT, mais aussi un sommaire de l'expérience acquérie dans cet effort pionnier. (*Tr. par George Benkowsky*)

Comparaison des images des tubes analyseurs "image orthicon" et "vidicon"

R. G. Neuhauser [696]

Le vidicon n'a pas, en principe, remplacé. "l'image orthicon" dans la télévision directe bien que sa définition soit aussi bonne ou meilleure et que sa sensibilité effective s'approche maintenant de celle de "l'image orthicon." La raison se trouve, tout d'abord, dans la différence fondamentale des caractéristiques des images obtenues par le vidicon et "l'image orthicon."

Ce sont les caractéristiques de la redistribution des électrons secondaires de "l'image orthicon"-électrons condamnés quelquefois parcequ'ils rendent des images inexactes-qui donnent l'impression que l'image est meilleure que celle à laquelle on pourrait s'attendre dans le système de télévision normal, si l'on considère l'oeil humain et le cerveau comme des éléments de ce système. De plus, ces caractéristiques compensent quelques abérrations fondamentales du système électron-optique de télévision. Traitées en détail sont les différences fondamentales des caractéristiques des signaux sortant de "l'image orthicon." Des méthodes sont données pour obtenir la meilleure performance de chaque tube.

Méthode pour produire des matériaux d'essai de densité déterminée pour télécinéma

Leslie H. Holmes [699]

Des cales d'essai en escalier à 10 gradins sur diapositives de 2" × 2" (51mm × 51mm) et film de 16mm ont été fabriquées à des valeurs de densité prédéterminées. L'auteur décrit, en grandes lignes, une méthode pour la corrélation entre le coefficient de réflexion du sujet et la densité négative, la préparation de bandes-papier à flash destinées à servir d'exemplaire original et les problèmes associés à la production d'une échelle prévue de densités.

Fibres optiques dans le tirage de films cinématographiques

Arthur J. Miller et Robert Hartshorne [701]

Plusieurs usages existent, dans les laboratoires de tirage, pour les "conduits lumineux" composés de fibres optiques. Il a été démontré que les systèmes lumineux de tireuses basés sur l'usage de fibres optiques ont de nombreux avantages. D'autres applications de ce procedé, pour la couleur et le blanc et noir, sont mentionnés dans cet article. (*Tr. par Edouard C. Conte*)

Des Systèmes intensificateurs d'images à rapport très élevé et la photographie de photons isolés avec résolution de temps en microsecondes

Martin L. Perl et Lawrence W. Jones [704]

On a utilisé un système composé de tubes intensificateurs d'images en cascade pour enregistrer photographiquement les images très pâles des pistes de particules à haute énergie dans les cristaux scintillants. Ce système, couramment employé dans la physique des particules à haute énergie, est d'une sensibilité suffisante pour enregistrer des photo-électrons isolés de la première cathode du système et est capable d'une résolution de temps de quelques microsecondes. Un emmagasinage de courte durée permet que la vanne électronique soit commandée par le processus en cause, de sorte que sur un total de 10^6 phénomènes survenant par seconde, il est possible d'enregistrer juste celui qu'on vise plus particulièrement.

L'article donne une description de système des tubes à images, ainsi qu'un résumé des propriétés intéressantes des tubes à images et lentilles disponibles. Les auteurs examinent aussi les limites dues aux bruits et à la résolution, ainsi que les perfectionnements à prévoir dans les tubes à images.

Enregistrement ombrographique d'images multiples par plaque lenticulaire

J. S. Courtney-Pratt [710]

Un nouvel appareillage a été construit, utilisant le principe de dissection d'image et l'éclairage par étincelle électrique. Une série de douze ombrogrammes consécutifs avec temps de pose inférieur à la microseconde peut être prise, les intervalles entre images pouvant être réglés à volonté de plusieurs secondes jusqu'à 2 μsec. La résolution atteint 600 lignes en travers du champs dans le sens vertical et dans le sens horizontal. Un dispositif du même ordre utilisant une pellicule lenticulée permet la prise de petites photographies avec résolution de 25 lignes/mm. On indique de nombreuses méthodes de déchiffrage de l'enregistrement composite.

Développement d'un tube obturateur photo-électronique

L. Mandel [716]

On est en train de développer un tube image photo-électronique qui peut s'employer comme obturateur à grande vitesse. Le tube est un intensificateur d'image avec dispositif magnétique de mise au point dans lequel le rayon photo-électronique passe à travers deux mailles en métal montées à quelques centimètres de la photo-cathode. La première maille remplit la fonction d'une grille de contrôle tandis que la deuxième sert comme électrode auxiliaire. Son emploi augmente la sensibilité de contrôle et rend la mise au point des électrons moins dépendante du potentiel de la maille de contrôle. Des tubes obturateurs ont été construits ayant une rangée de voltage de contrôle d'environ 3 v et une résolution de 15–20 lignes-paires/mm. La perte d'électrons à cause des mailles est moins de 20%. Des courbes démontrent la pénétration des électrons sous des conditions variées de coupage.

La télévision à haute sensibilité comme aide à l'enregistrement photographique à faible niveau lumineux

Bernhard A. Bang [719]

L'équipmente de télévision à circuit fermé et à haute sensibilité peut etre employé comme aide à l'enregistrement d'une scène dans les cas où la limitation effective d'exposition est en-dessous des possibilités de la photographie directe. La présentation de controle est photographiée par les techniques normales. La vitesse effective de ces systèmes a été rapidement accélérée au cours des trois dernières années. Des évaluations ASA équivalentes supérieures à 100.000 sont maintenant disponibles.

La sensibilité d'un équipment de télévision à circuit fermé judicieusement conçu dépend principalement du tube capteur et du système optique. Le tube le plus sensible qu'on pouvait obtenir depuis plusieurs années était le tube orthicon à images ou ses variantes. La sensibilité a maintenant été augmentée à un point tel que la variation statistique des photons lumineux reçus est une limitation. L'auteur passe en revue les caractéristiques de ces tubes, leur mode de fonctionnement et leur sensibilité relative.

Une caméra à stries f/1 pour les études d'étincelles dans les zones tant ultra-violette que visible

J. Dyson, R. F. Hemmings et R. T. Waters [725]

On a réalisé une caméra à stries et à miroir tournant qui est caractérisée par une vitesse d'enregistrement de 0,015 pouce/μsec, une ouverture de f/1 et un système optique à reflexion de type sphérique (sauf une fenêtre en quartz fondu). Cette caméra, qui est utile tant dans la zone ultra-violette que dans la région lumineuse visible, est munie d'un miroir tournant qui est actionné par un moteur électrique de 1500 t/s. On a mis au point une technique pour mouler le film de manière à le conformer à la surface focale sphérique nécessaire.

Cette caméra est utilisée pour étudier le régime d'engendrement des pannes électriques et la structure des entrefers de 2-m par les décharges à haute tension, en particulier les phénomènes à faible luminosité et à très grande vitesse qui précèdent la phase d'arc brillant finale. Cette dernière phase d'arc doit être supprimée afin d'éviter la production d'un voile prononcé sur l'enregistrement photographique. L'auteur décrit des techniques appropriées pour superposer les points de repère sur l'image afin de définir l'axe des temps, l'axe de l'entrefer, la position de l'étincelle dans l'espace et la vitesse d'enregistrement. Les photographies mettent en évidence l'apparition de la couronne filamenteuse la croissance de la décharge lumineuse à des vitesses supérieures à 10^8 cm/sec et la progression intermittente par gradins de l'amorce de l'étincelle.

Los teatros de Williamsburg Colonial para una película de participación en pantalla ancha

Arthur L. Smith y Ben Schlanger [677]

El plan general del proyecto para proporcionar una experiencia de participación como una introducción en la Williamsburg Colonial fue presentada previamente en una conferencia ilustrada, en 1955. Se presenta ahora la evolución y terminación del sistema en dos breves escritos que comprenden, primeramente, un bosquejo de la historia y la base del sistema para la presentación de la película, y luego, una descripción del sistema y sus facilidades.

Consideraciones acerca de la absorción de energía en la proyección cinematográfica

Eric A. Yavitz [686]

Se presentan los datos de las características de la absorción de energía de las películas en colores y en blanco y negro para darlas al público. Se han hecho los cálculos de la energía relativa absorbida por esas películas cuando se proyectan con arco de carbón de alta intensidad, en combinación con un reflector de plata o dicroico. Se comparan los resultados y se discuten su significación e implicaciones. Se analiza la distribución espectral de la energía incidente y su efecto importante sobre la exhibición de películas en colores.

Calculadora digital CBS-KNXT para el cambio de programas

Adrian B. Ettlinger [691]

En el nuevo estudio de televisión de la estación CBS-KNXT, situada en Hollywood, California, una calculadora digital para uso especial designada por la TRW Computers Co. está siendo usada para controlar los cambios de secuencia en los diversos componentes de los programas. El hacer automáticas las funciones de cambio durante los recurrentes "periodos de pánico" que ocurren en los cambios de programa, permite al operador dedicar su mejor atención al mantenimiento de la calidad de la producción. El uso de una computadora ha dado como resultado un sistema altamente adaptable con un número de aspectos convenientemente funcionales. En adición a la descripción detallada de la instalación de la KNXT, la experiencia lograda en este esfuerzo pionero está reseñada. (*Tr. de J. DeBraga*)

Características de imagen de los tubos de cámara vidicon y orticon

R. G. Neuhauser [696]

Por lo general, para la transmisión directa, el vidicon generalmente no ha podido replacer al orticon, a pesar que el vidicon es capable de una resolución tan buena o mejor y la sensibilidad efectiva hoy se llega acercar a la del orticon. Una característica muy propia del orticon, es la redistribución secondaria de los electrones, a veces se alega que esto produce una imagen inexacta, que puede contribuir a rendir una imagen que es aparentemente un tanto mejor que el sistema de televisión es normalmente capable de producir, es decir, si se considera que la vista y el cerebro humano forman parte de este sistema. Estas características igualmente compensan algunas de las aberraciónes básicas del sistema electro-optico de televisión. Se describe en detalle las características básicas de la señal generada por el orticon y vidicon. Se sugieren métodos para obtener el mejor funcionamiento de cada uno de los tubos. (*Tr. de Alex Quiroga*)

Un método como producir materiales de prueba de densidad específica para telecine

Leslie H. Holmes [699]

Se han fabricado transparencias de 5 × 5 cm y película de 16 mm con cuñas de prueba con una escala de diez pasos de valor de densidad predeterminada. El artículo describe en forma general un método como correlacionar la reflexión del sujeto original, con la densidad del negativo a medio de tiras de papel fotografico expuestos asi que sirvan como copia maestra. Se discuten los problemas implicados con la producción de esta escala de densidades calculadas de antemano. (*Tr. de Alex Quiroga*)

Las fibras opticas y su aplicacion a la impresion de peliculas cinematograficas

Arthur J. Miller y Robert Hartshorne [701]

Hay, en los laboratorios cinematográficos, diversas posibilidades de aplicación de los nuevos "conductores de luz", fabricados con fibras ópticas. Se ha podido constatar que los sistemas de iluminación para copiadoras cinematográficas, basados en el uso de una óptica de fibras, tienen muchas ventajas. Se describen varias otras aplicaciones de las fibras ópticas, tanto para copiar color como para copiar blanco y negro. (*Tr. de Pablo Tabernero*)

Unos sistemas intensificadores de imagenes de ganancia muy alta y la fotografia de fotones unicas con una resolucion en tiempo de microsegundos

Martin L. Perl y Lawrence W. Jones [704]

Se han usado un sistema compuesto de tubos intensificadores de imagenes en cascada para registrar fotográficamente los imagenes muy palidos de las huellas de particulas de energía alta en cristales chispeando. Este sistema, corrientemente empleado en la física de las particulas de energía alta, está de una sensibilidad suficiente para registrar unos fotoelectronos únicos del primer cátodo del sistema y el tiene la capacidad de una resolución de tiempo de algunos microsegundos. El almacenaje de duración corta permite que la paradero electrónica sea reprimido por el acontecimiento de interés, de suerte que sobre un total de 10^8 acontecimientos/sec., es posible de registrar justamente ese que se apunta más particularmente.

El articulo da una descripción del sistema de los tubos á imagenes, á una con un resumen de las propiedades interesantes de los tubos á imagen y lentes disponibles. Los escritores examinan también los limites debido á los ruidos y su resolución, así como los mejoramientos á prever en los tubos á imagenes.

Registro esquiagráfico múlitiple de imágenes en placa lenticular

J. S. Courtney-Pratt [710]

Se ha construído un nuevo aparato utilizando los principios de disección de imágenes e iluminación por chispas. Puede tomar una secuencia de doce esquiagramas cada uno de un tiempo de exposición de menos de un microsegundo, con los intervalos entre imágenes sucesivas variando convenientemente desde unos pocos segundos hasta 2 μseg. La resolución es 600 líneas a través del cuadro en ambas direcciones. Un sistema alterno utilizando uno film lenticulado permite tomar fotografías pequeñas con una resolución de 25 líneas/mm. Se describen varios procedimientos para desembrollar los registros colectivos.

Desarrollo de un tubo obturador fotoelectrónico

L. Mandel [716]

Se está desarrollando un tubo de imágenes fotoelectrónico utilizable como un obturador ultrarápido. Dicho tubo es un intensificador de imágenes enfocado magnéticamente, en el que se hace que el haz de foto-electrones pase a través de dos mallas metálicas montadas a pocos centímetros del fotocátodo. La primera malla actúa como una rejilla de control, mientras la otra sirve como un electrodo auxiliar. La introducción de su uso aumenta la sensibilidad de control y hace que el foco electrónico dependa menos del potencial de la malla de control. Se han hecho ya tubos obturadores con un régimen de voltaje de control de conexión-desconexión de alrededor de 3 voltios y una resolución de 15–18 líneas pares por mm. La pérdida de corriente electrónica debida a las mallas es menos de 20%. Se ofrecen las curvas que muestran la penetración de los electrones bajo diversas condiciones de corte.

La television de sensibilidad alta como una ayuda en la registracion fotografica a niveles bajos de luz

Bernhard A. Bang [719]

El equipo de televisión de circuito cerrado y de sensibilidad alta puede estar empleado como una ayuda en la registración de una escena en estos casos adonde la limitación efectiva de exposición está más abajo que las posibilidades de la fotografía directa. La presentación de control se fotografía por las técnicas normales. La rapidez efectiva de esto sistemas ha sido rapidamente acelerados en el curso de los tres años pasados. Ahora las evaluos equivalentes ASA superior a 100,000 son disponibles.

La sensibilidad de un equipo de televisión de circuito cerrado bien diseñado depende principalmente del tubo apresador y del sistema óptico. El tubo más sensible, que se puede obtener durante unos años pasados, fué el tubo órticon ó su variaciones. En este momento la sensibilidad ha sido aumentado hasta un punto tal que la variación estadística de los fotones luminosos recibidos está una limitación. Se discute los característicos de estos tubos, su modo de funcionar y su sensibilidad relativa.

Una Camara de huella a f/l Para estudios de chispas tanto en rayos ultravioladds como en rayos visibles

J. Dyson, R. F. Hemmings and R. T. Waters [725]

Se ha construido un cámara de huella con un espejo rotador de una rapidez de "escribir" cerca de 0.015 pulgada/μsec, una abertura de f/l, y, opticos de refexión esferico (á excepción de una ventana de cuarzo fundido). La cámara, que es útil igualmente en los alcances de rayos ultraviolados y rayos visibles, tiene un espejo rotador impulsado por un motor eléctrico de 1500 rps. Además se ha desarrollado una técnica de amoldar la película en derredor de la superficie focal esferica requerida por esta cámara.

Se usa la cámara para estudiar el fracasar eléctrico y su razón de desarrollo, y la estructura de las abras 2-m hecho por descargas de volaje alta, especialmente los procedimientos de muy gran rapidez y luminosidad baja que antecede la fase-arco brillante y final. Esta fase-arco debe ser suprimido para evitar una niebla densa sobre la registración. Se describe unas técnicas para sobreponer unas puntas de referencia en la imagen para definir el eje de tiempo, eje de abra, y posición-chispa en rapidez de espacio y "escribiendo." Fotografías mostre la aparencia de la corona filamenticia, el crecimiento de descarga luminiscencia á velocidades que excede 10^8 cm/sec, y el progreso escalonado discontinuo de la guia chispa.

Die "Colonial Williamsburg" Theater für einen Weitbild Teilnahme-Film

Arthur L. Smith
Ben Schlanger [677]

Die generelle Planung dieses Unternehmens, welches sich auf eine Teilnahmeerfahrung bezgl. Vertrautbarmachung mit dem kolonialen Williamsburg bezieht, wurde in einer im Jahre 1955 gegebenen Lektüre zur Vorschau gegeben.

Die Weiterentwicklung u. Vollendung des gg. Systems wird nun in zwei kurzen Schriften erörtert: einen Sketch, der auf die Basis u. Historie des repräsentiven Film-Systemes Bezug nimm, tsowie eine Beschreibung des Systemes selbst u. der verbundenen Ortlichkeiten. (*Üb. von Lucas G. Lawrence*)

Berücksichtigung der Energieabsorbierung in der Filmprojektion

Eric A. Yavitz [686]

Die hier gegebenen Daten beziehen sich auf die charakteristische Energieabsorbierung von vorführungsfertigem Farb- u. Schwarz/Weiss-Film. Die gemachten Kalkulierungen umfassen die relative Energieabsorbierung die dann auftritt, wenn die besagten Filme mittels einer Bogenlampe hoher Lichtdichte-plus einem silbernen oder dichromatischen Reflektor-projeziert werden.

Die Resultate werden verglichen, die gewonnenen Eindrücke u. Beurteilungen beschrieben. Das Thema der spektralen Verteilung, sowie der anfallenden Energie's wichtigen Einfluss über die schliessliche Leistung von Farbfilmen, wird hier erneut wiederholt. (*Üb. von Lucas G. Lawrence*)

CBS-KNXT System der Computer Kontrolle für Inter-programm Schaltung

Adrian B. Ettlinger [691]

In der neuen Sendestation CBS-KNXT (Hollywood, Kalifornia) wird ein besonders geeigneter Digital Computer für Regeln der aufeinanderfolgenden Schaltungen zwischen den verschiedenen Programmteilen benutzt, welcher von TRW Computer Co. entwurfen wurde. Dadurch, dass die starken Schaltaktivitäten während der häufigen Sendepausen jetzt automatisch vollbracht werden, ist es dem Techniker erlaubt seine Aufmerksamkeit hauptsächlich der Qualitäts-Erhaltung zu widmen. Der Gebrauch eines Digitalrechners bietet ein sehr vielseitiges System dar, durch eine Reihe bequemer Eigenarten. Zusätzlich der ausführlichen Beschreibung der KNXT Anlage, wird die Erfahrung gewonnen durch die Benutzung dieses bahnbrechenden Verfahrens beschrieben. (*Üb. von W. G. Connolly*)

Übertragungsmerkmale des Superorthikons und des Vidikons

R. G. Neuhauser [696]

Im Allgemeinen hat das Vidikon für Live-Sendungen noch nicht die Stelle des Superorthikons übernommen, trotzdem seine Bildauflösung gleich gut oder sogar besser ist, und trotzdem es nunmehr in effektiver Empfindlichkeit dem Superorthikon beinahe gleichkommt. Der Hauptgrund dafür liegt im grundsätzlichen Unterschied der Wiedergabecharakteristik der beiden Bildaufnahmeröhren.

Zurückfallende Sekundär-Elektronen, die oftmals als Ursache einer ungenauen Bildwiedergabe kritisiert werden, können den Anschein geben, dass das Superorthikon ein besseres Bild liefert als das verwendete Fernsehsystem überhaupt zu leisten imstande ist, vorausgesetzt, dass man menschliches Auge und Gehirn als Teil dieses Systems berücksichtigt. Diese charakteristische Erscheinung des Superorthikons kompensiert auch für einige der fundamentalen Verzerrungen in einem Fernseh Elektro-Optischen System.

Die vorliegende Arbeit detailliert die grundsätzlichen Unterschiede der Bildsignalerzeugung des Superorthikons und des Vidikons und schlägt Methoden vor, die zur Erreichung der besten Leistung von beiden Bildröhrentypen führt.

Ein Verfahren um Probe Materiale für Telecine von spezifischer Leuchtdichte herzustellen

Leslie H. Holmes [699]

Man hat 5 × 5 cm dia-platten und 16 m/m Schmalfilm mit zehn stufiger Graue-Keile mit vorherbestimmter Leuchtdichte als ein Mass-stab hergestellt. Im allgemeinen wird berichtet, wie der Lichtrückwurf von dem Subjekt mit der Leuchtdichte des Negativs in Wechselbeziehung gebracht wird und wie genau belichtete Papierstreifen zubereitet werden, um als Ur-Kopie zu dienen. Die miteinbegriffenen Probleme, einen solchen Mass-stab mit vorherbestimmten Leuchtdichten herzustellen, werden auch besprochen. (*Üb. von Alex Quiroga*)

Die Faseroptik und ihre Anwendung bei dem Kopieren von Filmen

Arthur J. Miller und Robert Hartshorne [701]

In der Kopieranstalt gibt es verschiedene Anwendungsmöglichkeiten der "Lichtleitung" mittels Faseroptik. Es konnte festgestellt werden, dass die Ausleuchtungssysteme für Kopiermaschinen, die sich der Faseroptik bedienen, viele Vorzüge haben. Es werden verschiedene andere Anwendungen der Faseroptik beschrieben, zum kopieren sowohl in Farbe als auch in Schwarz-Weiss. (*Üb. von Pablo Tabernero*).

Bildverstärkeranlagen besonders hoher Leistung un das Photographieren einzelner Photonen mit einer Zeitauflö.ung von Mikrosekunden

Martin L. Perl und Lawrence W. Jones [704]

Es wurde eine Anlage von Bildverstärkerröhren in Stufenanordnung verwendet, um die sehr schwachen Bildeindrücke der Spuren von Hochenergie-Partikeln in funkenden Kristallen photographisch aufzunehmen. Diese Methode ist gegenwärtig für Experimente in der Physik der Hochenergiepartikel im Gebrauch, ist genügend empfindlich um einzelne Photoelektronen von der ersten Kathode der Anlage aufzunehmen und gestattet eine Zeitauflösung von wenigen Mikrosekunden. Durch kurzfristiges Auflagern ist es möglich einen elektronischen Verschluss durch den wichtigen Vorgang so regeln zu lassen, das von 10^5 Vorgängen/s die sich ereignen, nur der eine Vorgang aufgenommen wird, der von besonderem Interesse ist.

Es wird eine Beschreibung der Anordnung der Bildröhren gegeben sowie eine Zusammenfassung der wichtigen Eigenschaften gegenwärge erhältlicher Bildröhren und Linsen. Es folgt ietin Erörterung der durch Geräusch und Auflösung gegebenen Grenzen und der Verbesserungen die von Bildröhren zu erwarten sind.

Linsenraster-Vielfach-Schattenbildaufnahmen

J. S. Courtney-Pratt [710]

Eine neue Vorrichtung bei der die Bildzerlegungs-Grundsätze und Funkenbeleuchtung verwendet werden wurde hergestellt. Es kann eine Reihenfolge von 12 Schattenbildaufnahmen von je einer Belichtungsdauer von weniger als einer Mikrosekunde bei zeitlichen Abständen zwischen hintereinanderfolgenden Bildern von einigen Sekunden bis 2 Mikrosekunden wunschgemäss erzielt werden. Ein Auflösungsvermögen von 600 Linien über das Feld in beiden Richtungen ist erzielbar. Ein gleichwertiges System mit Linsenrasterfilm gestattet kleine Bilder mit einem Auflösungsvermögen von 25 Linien/mm aufzunehmen. Mehrere Methoden für die Auflösung der komplexen Aufnahmen werden beschrieben.

Entwicklung einer photoelektronischen Verschlussröhre

[716]

L. Mandel

Eine als Hochgeschwindigkeitverschluss verwendbare photoelektronische Bildröhre wird entwickelt. Die Röhre ist ein magnetisch eingestellter Bildverstärker, worin der photoelektronische Strahl durch zwei Metallmaschen geführt wird, die ein Paar Zentimeter von der Photo-Kathode angebracht sind. Die erste Masche dient als Kontrollgitter während die zweite dient als Hilfselektrode. Ihr Gebrauch vergrössert die Empfindlichkeit der Kontrolle und ermöglicht, dass der Elektron-Fokus weniger von dem Potential der Kontrollmasche abhängt. Verschlussröhren sind schon angefertigt, die einen Kontrollspannungsbereich von ungefähr 3 v und ein Auflösungsvermögen von 15–20 Linienpaaren/mm besitzen. Der Verlust an Elektronstrom durch die Maschen ist weniger als 20%. Kurven sind beigefügt, die die Penetration der Elektronen unter verschiedenen Sperrbereichbedingungen vorzeigen.

Hochempfindlichkeits-Fernsehen hilft photographischen Aufnahmen bei niedrigem Lichtpegel

BERNHARD A. BANG [719]

Hochempfindlichkeits-Fernsehgeräte mit geschlossenem Stromkreis können dazu dienen eine Szene aufzunehmen, bei der die Belichtungszeit beschränkt und unter der für direkte Photographie nötigen ist. Die Begleitdaten werden suf normale Weise photographiert. Die wirksame Geschwindigkeit solcher Anlagen hat sich in den leztten drei Jahren stark erhöht. Es sind gegenwärtig Lichtstärken verfügbar die mehr als 100.000 ASA entsprechen.

Die Empfindlichkeit eines gut gebauten Fernsehgeräts für geschlossenen Stromkreis hängt hauptsächlich von der Aufnahmeröhre und der Optic ab. Die empfindlichste Röhre, die in den letzten Jahren erhältlich war, ist die Image Orthicon oder ihre Varianten. Die Empfindlichkeit wurde bis zu einem solchen Punkt gesteigert, dass die Grenze durch die statistische Variation an aufgenommenen Lichtphotons gebildet wird. Es werden die Charakteristiken dieser Röhren, ihre Arbeitsweise und ihre relative Empfindlichkeit erörtert.

Eine f/1-Streifenkamera für Funkenuntersuchungen im ultravioletten und sichtbaren Lichtbereich

J. DYSON, R. F. HEMMINGS und R. T. WATERS [725]

Eine Streifenkamera mit Rotationsspiegel und mit einer 0,015 in. (0,038 cm)/μSek. Schreibgeschwindigkeit, einer f/1 Objektivöffnung und einer sphärischen Reflexionsoptik (mit Ausnahme eines Fensters aus geschmolzenem Quartz) ist konstruiert worden. Die Kamera, die nicht nur im ultravioletten, sondern auch im sichtbaren Lichtbereich brauchbar ist, hat einen rotierenden Spiegel, der durch eine elektrischen Motor von 1500 U.p.M. angetrieben ist. Eine Technik, die es ermöglicht, den Film der erforderlichen sphärischen Brennpunktsfläche entsprechend abzuformen, wurde entwickelt.

Die Kamera wird angewandt um die Verlaufsgeschwindigkeit des Durshschlags und die Struktur der 2-m Luftspalten bei Hospannungsentladungen, hauptsächlich die der leuchtenden Schlussphase des Bogens vorangehende Vorgänge die eine niedrige Leuchtkraft besitzen und die mit grösster Geschwindigkeit vor sich gehen, zu untersuchen. Diese letztgenannte Bogenphase muss unterdrückt werden um eine starke Verschleierung der Aufnahme zu vermeiden. Die Technik, die es ermöglicht Bezugspunkte auf dem Bilde zu überlagern um die Zeit- und Spaltachse, sowie Funkenlage im Raum und Schreibgeschwindigkeit zu bestimmen, wird beschrieben. Aufnahmen zeigen das Auftreten der Fadenkorona, das Anwachsen der Glimmentladung bei Schnelligkeiten die mehr als 10^8 cm/Sek. betragen und den diskotinuierlichen Stufenablauf des Leitfunken.

Ed. Note: Titles and abstracts of all papers published in the *Journal* are published in French, Spanish and German. This department (Résumés/Resumenes/Zusammenfassungen) was set up in recognition of the growth in the Society's overseas membership, and first appeared as a regular feature of the *Journal* in the January 1961 issue. Comments and suggestions are invited on the quality and possible improvement of the translations. Because of the prohibitive cost of commercial translations, volunteer help is needed, and such assistance will represent an important contribution to the Society. Contributors will, of course, be given full acknowledgment in the *Journal*.

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News Columns

Advertisers

Meeting Calendar

IRE, AIEE, Industrial Electronics Symposium, Sept. 20–21, Boston, Mass.

American Physical Society, Meeting, Sept. 24–25, Univ. of Chicago.

AICE, National Meeting, Sept. 24–27, Lake Placid Club, Lake Placid, N. Y.

Illuminating Engineering Society, National Technical Conference, Sept. 24–29, Chase-Park Plaza Hotel, St. Louis, Mo.

Electrochemical Society, Fall Meeting, Oct. 1–5, Statler Hotel, Detroit, Mich.

IRE, Canadian Electronic Conference, Oct. 2–4, Automotive Bldg., Exhibition Park, Toronto, Ont.

90th Semiannual Convention of the SMPTE, Oct. 1–6, Lake Placid, N.Y.

American Rocket Society, Twelfth International Astronautical Congress, Oct. 2–7, Washington, D. C.

National Electronics Conference, Oct. 9–11, International Amphitheatre, Chicago.

American Rocket Society, Space Flight Report to the Nation, Oct. 9–15, New York Coliseum, New York.

American Standards Association, National Conference, Oct. 10–12, Rice Hotel, Houston, Texas.

AIEE, Fall General Meeting, Oct. 15–20, Statler-Hilton Hotel, Detroit.

ASCE, Annual Meeting, Oct. 16–20, Hotel Statler, New York.

Optical Society of America, Fall Meeting, Oct. 18–20, Biltmore Hotel, Los Angeles.

Acoustical Society of America, Meeting, Nov. 9–11, Cincinnati and Dayton, Ohio.

Air Force Office of Scientific Research, Second International Conference on the Exploding Wire Phenomenon, Nov. 14–16, Boston, Mass.

ASME, Annual Meeting, Nov. 26–Dec. 1, Hotel Statler, New York.

Society of Reproduction Engineers, Visual Communications Congress, Dec. 1–4, Hotel Biltmore, Los Angeles.

AICE, Annual Meeting, Dec. 3–7, Hotel Commodore, New York.

American Association for the Advancement of Science, Annual National Meeting, Dec. 26–31, Denver Hilton, Brown Palace, Cosmopolitan, Shirley Savoy Hotels, Denver, Colo.

AIEE, Winter General Meeting, Jan. 28–Feb. 2, 1962, Hotel Statler, New York.

AICE, National Meeting, Feb. 4–7, 1962, Statler-Hilton, Los Angeles.

American Society of Photogrammetry, Annual Convention, Mar. 11–17, 1962, Washington, D. C.

IRE International Convention, Mar. 26–29, 1962, New York.

91st Semiannual Convention of the SMPTE, Apr. 29–May 4, 1962, Ambassador Hotel, Los Angeles.

SPSE Annual Conference, May 7–11, 1962, Somerset Hotel, Boston, Mass.

6th International Congress on High-Speed Photography, Sept. 17–22 1962, Hotel Kurhaus, Scheveningen, Netherlands.

92nd Semiannual Convention of the SMPTE, Oct. 21–26, 1962, Drake Hotel, Chicago.

93rd Semiannual Convention of the SMPTE, Apr. 21–26, 1963, Traymore Hotel, Atlantic City, N.J.

94th Semiannual Convention of the SMPTE, Oct. 13–18, 1963, Somerset Hotel, Boston.

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SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1961 Journal.

sustaining members

of the Society of Motion Picture and Television Engineers

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- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

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